Sediment Phthalates Work Group

Summary of Findings and Recommendations

Prepared by

City of Tacoma
City of Seattle
King County
Washington State Department of Ecology
U.S. Environmental Protection Agency

with assistance from

FLOYD | SNIDER

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Introduction and Background

Stimulated by phthalate recontamination at sediment cleanup sites, the cities of Tacoma and Seattle, King County, Washington Department of Ecology (Ecology), and the U.S. Environmental Protection Agency voluntarily came together in 2006 to form the Sediment Phthalates Work Group (the Work Group). The Work Group (comprised of the Technical Committee and the Policy Committee; refer to Appendix A) was formed based on a shared recognition of the challenges municipal governments face in locations such as the Thea Foss Waterway and Lower Duwamish River from accumulations of phthalates in sediments soon after sediment cleanups have occurred.

The Work Group's goal was to work together to summarize and evaluate existing information on phthalate sediment contamination issues, identify data gaps, and provide recommendations to address phthalate sediment contamination for regulatory agencies and the community to consider.

Work Group members recognized that the agreement to collaborate on understanding sediment phthalates does not preclude the agencies from implementing their authorities as appropriate. The group also recognized that it would be the regulatory agencies' decision(s) to pursue any recommendations related to regulatory approach and that those decisions would not be made within the Work Group.

During the 10-month process, the Work Group collected, summarized, and evaluated existing information to:

- Document where phthalates are found and identify potential sources.
- Define phthalate contamination concerns within current regulations.
- Place sediment phthalate concerns in perspective with other sediment contamination risks and within the broader issue of phthalate risks from other exposure pathways.
- Identify potential source control and treatment options.
- Provide recommendations on next steps.
- Share findings with the public.

The Work Group developed recommendations for addressing the sediment phthalate problem, which are presented in this document. The recommendations involve the following general areas of potential action:

- Further study and research to validate the Work Group's findings regarding the problem and identify other contaminants that follow pathways similar to phthalates
- Education of appropriate agencies and the community on the Work Group's findings
- Interaction with Puget Sound Partnership and air agencies to address the air–stormwater–sediment pathway
- Evaluation and implementation (where appropriate) of stormwater source control and treatment options

- Management of phthalate recontamination at cleanup sites through site-specific operation and monitoring plans
- Consideration of a Sediment Management Standard (SMS) rule amendment to address phthalates and other pervasive pollutants
- Coordination with other phthalate risk initiatives
- Development of recommendations regarding plasticized polyvinyl chloride (PVC; (alternatives, building material standards, bans, engagement with plastics industry, incentives, etc.).

The Technical Committee completed research and technical discussions in May 2007. Upon completing research on the four topic areas — (1) Occurrence, (2) Sources, (3) Risk & Receptors, and (4) Source Control & Treatment — the Work Group developed a "Comprehensive Problem Statement", which is presented in the following sections of this document, along with a detailed description of Work Group recommendations. Appendix B provides all the final meeting notes of the Work Group and Appendix C provides a bibliography of references used and cited. Final versions of all the meeting notes and other final products produced by the Work Group can also be found on the Ecology website: http://www.ecy.wa.gov/programs/tcp/smu/phthalates/phthlates_hp.htm.

A key aspect of the Comprehensive Problem Statement was the recognition that phthalates reach sediments via a complex and fascinating pathway involving off-gassing to air followed by attachment to particulates, deposition to the ground and transport to sediments through stormwater (Figure 1). This pathway was not initially obvious; the group pieced it together based on researching phthalate use in the marketplace, resulting potential sources, and occurrence in various environmental media.

The understanding and recognition of this air–stormwater–sediment pathway was crucial to the Work Group's understanding of the overall problem and development of recommendations. The Work Group has also come to believe that the air–stormwater–sediment pathway is very important to understand relative to the behavior of other pollutants in the urban environment.

Because of the critical importance of the air–stormwater–sediment pathway understanding to the Work Group's recommendations, and because the pathway is not readily apparent from review of the referenced literature, the Work Group decided to provide a detailed summary of the research and findings used to develop the pathway conclusions. This material is provided in Appendix D.

Comprehensive Problem Statement Regarding Phthalates in Sediments

ABOUT THIS PROBLEM STATEMENT

This "comprehensive problem statement" is a general summary of findings from the research performed by the Technical Committee on Sediment Phthalate Occurrence, Sources, Risk & Receptors, Source Control & Treatment, and Potential & Regulatory Framework. Please refer to Appendix D for a more detailed discussion on the fate and transport of phthalates to sediments.

It is important to note that this project focused on phthalates accumulated in sediment. As with all previous notes from the Work Group, the term "phthalate" in the following discussion refers to either Di-(2-Ethylhexyl) Phthalate (DEHP) or Butyl Benzyl Phthalate (BBP).

The Work Group found that phthalates in cosmetics, medical apparatus, toys, etc. are not often DEHP or BBP. These "other" phthalates pose different health risks than DEHP and BBP and have different fate and transport pathways. These other phthalates have not generated concerns at sediment sites known to this Work Group, so they were not evaluated.

PHTHALATES MOVE FROM PVC PRODUCTS INTO THE AIR AND THEN TO SEDIMENTS

Certain phthalates accumulate in sediments in localized areas at the end of urban stormwater outfalls. These phthalates, primarily DEHP and BBP, are plasticizers used in plasticized PVC throughout urban commercial and residential neighborhoods. Plasticized PVC is a fundamental component in numerous materials (e.g., vinyl flooring, shower curtains, etc.) that are important to our economy (refer to Figure 1).

Based on its research, the Work Group believes that the primary, urban pathway by which phthalates reach sediments begins when plasticized PVC products off-gas phthalates into the surrounding atmosphere. These phthalate-containing materials continually off-gas until most of the phthalate is released, leaving the product brittle. These vapor phase phthalates stick to fine particulates in the air, which are then deposited on soils and surfaces throughout the watershed (Figure 1). When it rains, this particulate matter washes off surfaces — particularly impervious surfaces like pavement, roofs, and cars — and into storm drains. Consequently, watersheds with more impervious surfaces (i.e., urban or metropolitan population areas) contribute a larger mass of phthalates to sediments than watersheds with less impervious surfaces. These densely populated urban areas also contain a greater mass of plasticized PVC products, which increases the reservoir of phthalates available for transport to sediments.

PHTHALATES BUILD-UP IN SEDIMENTS

Phthalates do not appreciably dissolve in water; they tend to stick on air-borne particulates until they are deposited on impervious surfaces, where they can be washed into storm drains and carried to receiving waters and sediments. By this process, phthalate concentrations may increase in sediments over time — particularly when the receiving water body is quiescent or slow-moving. In quiescent aquatic environments, phthalates adhered to particulates don't tend to move very far and tend to concentrate. Consequently, when phthalates accumulate in sediments to levels of regulatory concern, the affected area is typically localized.

PHTHALATES DO NOT TRIGGER REGULATORY RESPONSE WHEN DIFFUSED IN THE AIR AND WATER

When these phthalates are in the air and water, before reaching the sediments, concentrations do not generally trigger a regulatory response due to human or environmental health concerns. However, within a few years, phthalates can accumulate in sediments to levels that can be toxic to benthic organisms (e.g., worms, clams, oysters), which are at the bottom of the food chain, living in and on the sediments.

BUILD-UP IN SEDIMENTS IS TOXIC TO BENTHIC ORGANISMS — BUT IS A MINIMAL CONCERN UP THE FOOD CHAIN

Phthalates in sediments do not readily bioaccumulate. Instead, it appears that organisms at the higher trophic levels metabolize phthalates and excrete them. Ecology set numeric and biological criteria for sediment quality in the SMS under the authority of the Washington State Water Pollution Control Act and Model Toxics Control Act (MTCA). The purpose of the SMS is to reduce and ultimately eliminate adverse effects on biological resources and significant health threats to humans from surface sediment contamination. Washington is the only state with promulgated sediment standards that include criteria for phthalates. Although phthalates are toxic to benthic organisms, sediment concentrations pose a minimal risk to larger animals and human health[1].

PHTHALATES DON'T DRIVE SEDIMENT CLEANUPS — BUT CAN BUILD-UP AGAIN QUICKLY AT CLEANED-UP SITES

Sediment cleanups are typically performed to address historical contamination and multiple contaminant types. Sediment cleanup sites that have quiescent receiving waters and receive runoff from large urban watersheds are seeing phthalates reaccumulate to levels that exceed the Washington SMS criteria after the original cleanup (e.g., Thea Foss, Diagonal/Duwamish). Because sediment phthalates pose a low human health risk compared to other contaminants, and because it is important to remove those other sediment contaminants, it is important that initial sediment cleanups not be delayed due to concerns about potential phthalate recontamination.

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[1] There is limited information about ecological risk and impacts of phthalates. The Lower Duwamish Waterway human health risk assessment indicates that phthalates pose a risk for a small percentage of the subsistence seafood consumers eating seafood only from the Lower Duwamish. That risk was slightly greater than regulatory levels and much less than the risk from other chemicals in the same seafood.

PHTHALATE SOURCES ARE PRESENT THROUGHOUT CITIES AND DUST IN THE AIR ATTRACTS PHTHALATES

Billions of pounds of plasticized PVC products are currently in the urban environment (e.g., vinyl flooring and siding, electrical cable covering, carpet, shower curtains, etc.). These plasticized materials will continue to off-gas phthalates until the products are brittle and no longer contain phthalates, which takes many years. As long as dust is in the air, phthalates will stick to these particulates and will be deposited on exposed surfaces. Air containing higher concentrations of fine particulates draws more phthalates out of plasticized PVC, which can be deposited on the impervious surfaces (refer to Figure 1). Thus, there appears to be a broad, positive correlation between phthalate sources, air particulates, and sediment concentrations. Phthalate loading to sediments increases with air particulate concentrations and urbanization.

BANNING PHTHALATE SOURCES AND ALTERNATIVES TO PHTHALATES

One possible way to decrease the amount of phthalates in the environment would be to ban the use of phthalates in plasticized PVC. A national ban on phthalates as plasticizers could be effective; however, because the existing reservoir of plasticized PVC in the environment will continue to release DEHP, the effects of a ban would not likely be measurable for several years or more.

Alternatives to phthalates are being evaluated by the plasticizer industry. This work is motivated by the need to reduce human health effects from direct exposure to medical apparatus, toys, and cosmetics. These initiatives could potentially develop and publicize information about production substitutes or increase their availability — all of which could potentially reduce phthalate inputs to sediments.

AIR QUALITY IMPROVEMENTS AND LOW-IMPACT STORMWATER DEVELOPMENT WOULD HELP

Phthalate loading to storm drains could be reduced by removing fine particulates from the air or by increasing pervious surfaces within a watershed to reduce stormwater runoff quantities. These actions also have many additional environmental benefits and have positive synergy with many other environmental sustainability initiatives.

It is very difficult to treat stormwater to remove fine particulates effectively because stormwater quality and flow are highly variable, even in areas that are not urbanized. In urban areas flow rates vary dramatically as the amount of impervious surface (e.g., roofs, roads, and parking lots) increases while, at the same time, the amount of space available for treatment decreases. Even if effective control technologies and the space to implement them existed, the Work Group believes that phthalates would still reaccumulate (although the rate of reaccumulation would likely be slower).

OUR REGULATORY PROGRAMS DO NOT WORK WELL FOR PERVASIVE POLLUTANTS THAT MOVE ALONG THIS AIR–STORMWATER–SEDIMENT PATHWAY

Existing regulatory tools and programs are not well designed to effectively address this type of pervasive pollutant with a multimedia pathway. Current regulations address separate parts of the overall phthalate pathway from sources to sediments; however, existing regulations tend to focus only on one media and direct sources to that media, such as surface water, air, or soil. There is no single regulation that is effective for controlling phthalate sources along the path to sediments and the group feels that this is a significant gap. Regulations for the end-of-pipe do not control the products or media at the beginning of the pathway, and the controls currently available for stormwater at the end-of-pipe will not prevent phthalate reaccumulation in sediments.

THERE ARE OTHER POLLUTANTS THAT BEHAVE LIKE PHTHALATES THAT POSE GREATER RISKS

Phthalates are among several ubiquitous urban contaminants (PAHs, zinc, copper, etc.) that become greater problems as population and urban development increase. Phthalates travel to sediments primarily along an air–stormwater–sediment path that may also be an important pathway for these other urban contaminants. In general, many of these other urban contaminants in Puget Sound pose greater sediment risks (in terms of human health and the environment) than phthalates.

PHTHALATE RECOMMENDATIONS SHOULD ALSO ADDRESS OTHER AIR–STORMWATER–SEDIMENT PATHWAY CONCERNS

Recommendations to address phthalate recontamination should be considered in the broader context of pollutants that behave similarly. Where appropriate, recommendations should be implemented in a manner that addresses a broader set of pervasive urban contaminants that also move along an air–stormwater–sediment pathway.

This includes the studies that are put forward for consideration, and the potential work that could be done to consider a more comprehensive, integrated regulatory approach to the air–stormwater–sediment pathway.

This approach to consider phthalates in a broader context could more efficiently utilize available funding to focus on multiple problems that are meaningful to the health of Puget Sound.

Recommendations

1. Manage Phthalate Reaccumulation at Cleanup Sites Using Site-specific O&M Plans

Develop considerations related to phthalate reaccumulation to be taken into account in development of site-specific O&M plans for CERCLA and MTCA sediment cleanup sites. This can likely be performed by the Technical Committee of the Work Group, and would serve as a starting point for consistent criteria to be considered on a site-specific basis.

- Considerations could include developing appropriate triggers for action (i.e., localized size of impacted area and level of exceedances, co-occurrence with other target pollutants, beneficial use-specific targets) and options for ongoing O&M and triggered actions (i.e., continued monitoring, thin layer capping or removal, outfall engineering).

Consider relationship to National Pollutant Discharge Elimination System (NPDES) requirements that are tied to SMS.

2. Studies/Research to Further Validate our Comprehensive Problem Statement and Define Other Pollutants Transported via an Air–Stormwater–Sediment Pathway

Define the other pollutants that are pervasive in the Puget Sound area and are transported to sediments along the same transport mechanism (air-stormwater-sediments) as phthalates.

Study their characteristics, sources, and risks, in order to identify those compounds that could also be addressed through solutions related to the air–stormwater–sediment pathway.

Characterize identified compounds relative to particle size range in air, stormwater, catch basins, and sediments. Develop a better-defined model of this transport pathway, and evaluate the mass balance links from air to sediments.

- Confirm assumptions about the pathway. Document drainage basin and airshed characteristics at outfalls of concern.
- Develop an air toxics high-volume sampling technique for phthalates and other compounds, as appropriate.

Study the breakdown of phthalates (and potentially other constituents). Determine how quickly they degrade in the various environments along the pathway — in air, fresh water, marine water, marine sediments, freshwater sediments, and soils.

Evaluate the percentage of identified phthalates (and potentially other constituents) in sediments that are coming via the air pathway. Acknowledge other sources of phthalates (marinas, phthalate handlers, etc.) and study those other sources. Consider source sampling at marinas and updating sediment trap source identification work.

3. Coordinate with Puget Sound Partnership and Air Agencies Regarding The Air–Stormwater-Sediment Pathway and Related Contaminants

Coordinate and communicate to Puget Sound Partnership and Air Agencies regarding sediment contamination air pathway sources. Coordinate with air agencies to increase awareness and work jointly on recommendations.

Inform organizations looking at regulatory change and Puget Sound wide issues regarding this multi-media/source perspective for identified contaminants.

Use existing legislative and regulatory frameworks to define how the air–stormwater–sediment pathway could be more effectively addressed/controlled, or develop a better regulatory/statutory approach to address multimedia pathways.

Based on acknowledgement that there are sources of pervasive pollution following an air-to-sediment pathway that will continue following cleanup, develop and/or modify the current regulatory framework to address unavoidable impacts that can not be controlled or mitigated.

4. Jointly Evaluate Effective Solutions for the Air–Stormwater-Sediment Pathway with Puget Sound Partnership and Air Agencies,

Recognize that many solutions could address multiple contaminants and provide additional environmental benefits.

Support active organizations in pursuing a ban on phthalates when the industry has identified a practical substitute. Work with industry to develop these substitutes.

Evaluate effectiveness of air quality initiatives (such as the reduction of diesel or other fine particle emissions) to reduce sediment impacts.

Develop programs for encouraging reduction in effective impervious surfaces within watersheds (through reduction in pavement or increase in infiltration) to decrease runoff and increase permeability. Evaluate effectiveness to reduce sediment impacts.

Consider public incentives or funding for voluntary actions that implement phthalate control priorities.

Consider environmental mitigation as a solution to unavoidable sediment impacts within limited areas.

Study bioremediation or other in-situ remedies for compounds of interest in sediments.

5. Educate Agency and Community "Stakeholders" Regarding the Comprehensive Problem Statement

Provide education within member organizations and to community stakeholders regarding phthalate sediment reaccumulation — including information regarding phthalate sources, risks and regulatory drivers, air–stormwater–sediment pathway, and control alternatives.

Explain phthalate human health concerns in other contexts — there may be other areas where phthalates can cause concerns.

Start to shift thinking regarding source control, to acknowledge that there are sources of phthalates that will continue following cleanup, at least in the near term.

Raise awareness about the air–stormwater–sediments pathway, which may be very relevant to other Puget Sound cleanup efforts.

Raise awareness about actions and solutions that can help the sediment phthalates issue and also meet other environmental goals.

6. **Develop recommendations regarding plasticized PVC (which could also be potentially extended to other products that are sources of air-sediment pathway contaminants).**

   Evaluate and develop environmentally sustainable alternatives to phthalates as a plasticizer.

   Adjust LEED (Leadership in Energy & Environmental Design) building standards to address plasticized PVC. Evaluate and develop substitutions for plastics in construction materials.

   Engage U.S. industry so the problem — including all pathways of exposure — is not ignored. Get on the industry's radar at the national level to help evaluate solutions. Consider implementation of a "Cradle to Grave" law — in which those responsible for putting phthalate into products would be responsible for addressing environmental consequences.

   Consider building code modifications regarding plasticized PVC product use in construction materials.

   Consider tax or incentive mechanisms regarding product use and emissions, and to assist in funding source control priorities. Educate the public to make associated lifestyle changes.

7. **Coordinate with Other Phthalate Risk Initiatives**

   Work with initiatives that are addressing phthalate risks from other exposure pathways (cosmetics, toys, medical, etc) to develop solutions that could also benefit sediments.

   If studies or multiple pathway focus supports one of these, then implement bans, product substitution, or coatings to reduce phthalate sources. Negotiate with foreign producers to institute product substitution or reduction.

   Support studies on product/plasticizer alternatives and coatings (and product substitutions for other pervasive contaminants) and their potential concerns, benefits, and costs.

8. **Evaluate Stormwater Source Control and Treatment Options and Implement Where Justified**

   Evaluate source control and treatment options for phthalates and potentially other identified air-to-sediment pathway compounds. Consider implementation where studies predict actions to be relevant and effective. Consider potential multiple benefits of selected technologies and cost justification.

Perform studies on street sweeping, catch basin cleaning, and other O&M. Implement where relevant/effective.

Perform systematic evaluation of stormwater treatment alternatives with selected pilots. Implement those treatment methods that are feasible.

Evaluate costs and benefits of source control and treatment options for identified compounds versus repeated cleanup in area of impact. Evaluate cleanup options relevant to areas of outfall impacts for utilizing in site-specific decision making.

Recommend directing research on “green chemicals” to compounds like phthalates — not just for more toxic compounds.

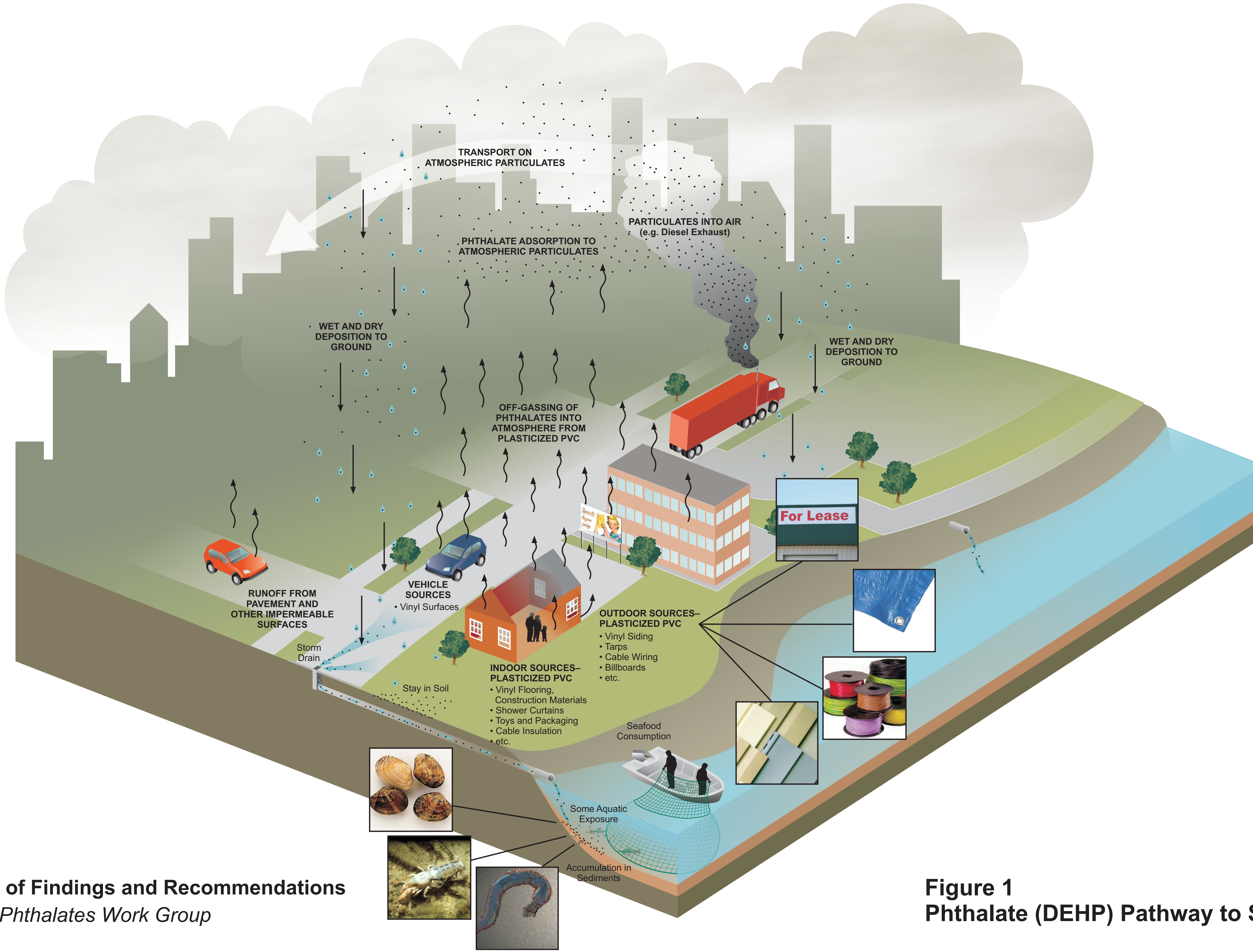
9. Consider SMS Rule Amendment to Address Phthalates and Other Pervasive Pollutants

Explore potential for an SMS rule amendment, to add consideration to SMS for addressing pervasive pollutants, such as protocols for making decisions regarding the cleanup trigger for phthalates and similar pollutants. Consider narrative criteria that could be added to SMS based on additional information collected in the Work Group. In doing so, think through MTCA/SMS relationships. Consider parallel actions under Superfund.

Sediment Phthalates Work Group

Summary of Findings and Recommendations

Figures



Summary of Findings and Recommendations
Sediment Phthalates Work Group

Figure 1
Phthalate (DEHP) Pathway to Sediments

Appendix A

List of Sediment Phthalates Work Group Members

Sediment Phthalates Work Group Members

Technical Committee	
DeJesus, Kathryn	WA State Dept. of Ecology
Flint, Kris	EPA
Moore, Bill	WA State Dept. of Ecology
O'Loughlin, John	City of Tacoma
Preston, Seth	WA State Dept. of Ecology
Rude, Pete	City of Seattle
Stern, Jeff	King County
Tiffany, Bruce	King County
Policy Committee	
Adair, Janice	WA State Dept. of Ecology
Baker, Martin	City of Seattle
Cohen, Lori	EPA
Larkin, Karen	City of Tacoma
Peeler, Dave	WA State Dept. of Ecology
Theiler, Donald	King County
Other Contributors	
Jack, Richard	King County
Schmoyer, Beth	City of Seattle
Facilitators	
Murray, Erin	Floyd|Snider
Snider, Kate	Floyd|Snider

Appendix B

Meeting Notes

Phthalate Work Group Meeting Notes
August 10, 2006

ATTENDEES

John O'Loughlin	City of Tacoma	joloughl@cityoftacoma.org
Kris Flint	EPA	flint.kris@epa.gov
Bill Moore	WA Dept. of Ecology	Bmoo461@ecy.wa.gov
Kathryn DeJesus	WA Dept. of Ecology	Kbco461@ecy.wa.gov
Noel Treat	King County	Noel.treat@metrokc.gov
Jeff Stern	King County	Jeff.stern@metrokc.gov
Bruce Tiffany	King County	Bruce.tiffany@metrokc.gov
Pete Rude	City of Seattle	Pete.rude@seattle.gov
Kate Snider	Floyd|Snider (facilitation)	kate.snider@floydsnider.com
Drew Hilen	Floyd|Snider	drew.hilen@floydsnider.com

This meeting summary was prepared by Kate Snider and Drew Hilen. It is based on a transcription of the flip charts used during the meeting to document the discussion. Action items are identified in ***bold script***.

PURPOSE OF THE MEETING

This meeting is the first for the Phthalate Work Group. The meeting will address the short term and long term goals of the Work Group and have initial discussions regarding working principles, the formation of a charter and a work plan. Future meetings will be set.

AGENDA

- Charter / Working Principles
- Purpose and Expected Outcomes
- Scope and Schedule Outline (big picture)
- Stakeholder Involvement
- Future Meetings and Homework

CHARTER/WORKING PRINCIPLES

- The Work Group will focus only on phthalates, with sediment deposition as an end point. However, the Work Group recognizes that this process and its recommendations might be useful as precedent for addressing other similar contaminants in separate initiatives.

- The work will be based on a robust review of existing data, recent papers, and available information other cities/regions have collected on phthalate contamination. New data collection is not expected for the initial effort, but outcomes may include recommendations for additional data needs.
- Consistent participation by the individuals identified as Work Group members is important to project success.
- Products will be developed on behalf of the 5 member agencies (City of Tacoma, City of Seattle, King County, Ecology and EPA).
- The purpose of this group is to develop shared understandings of information and provide recommendations <u>not</u> decisions.
- Useful interim products are expected to be outcomes at key milestones – recommendations of the group should not be held to the end of the project duration.
- Policy leads should be involved at key milestones. Policy leads have asked to be updated at least every 4 months.
- The work environment will be Collaborative. This 'sleeves rolled up' approach should help promote ideas and also convey a sense of freedom to share ideas, data, previous work and suggestions related to phthalates.
- The group recognizes that the participant regulatory agencies (Ecology and EPA) wear several hats, and time may be needed for internal coordination.
- Multiple departments within Work Group agencies should participate if necessary to develop practical recommendations.

PURPOSE & OUTCOMES

- Put phthalate contamination in perspective – work as a group to develop a shared understanding of the magnitude of the problem & approaches to deal with it.
- Define the problem - phthalate concerns and associated issues
    - Risks and receptors
    - Sources
    - Source control and treatment options
    - Regulatory framework
    - Implications for cleanups
- Reach shared understanding of current info – compile, report to policy and message to stakeholders. Reports/written products should help define phthalate situation for multiple stakeholders and community.
- Develop common messages for stakeholders and community.
    - Early joint messages to the public and media are important.

- Make recommendations re: clear expectations regarding recontamination and source management before cleanups are conducted. Make recommendations regarding interim approaches.
- Make recommendations for completed cleanup sites that are recontaminating.
  - Site specific recommendations (Thea Foss, Duwamish).
- Make recommendations for short-term fixes with the understanding that they will be incorporated into long-term solutions. Also recommend ideas for long-term solutions.

SCOPE AND SCHEDULE

The general project approach was discussed, and identified as having three primary steps:

1. **Defining the problem/ facts/situation.** Four primary topic areas were defined for evaluation:
   - Phthalate occurrence
   - Risk and receptors
   - Source identification
   - Source control and treatment technology options

   For each primary topic area, subgroups (study groups) within the Work Group would assemble existing information to bring back to the Work Group for presentation and discussion:
   - Body of information we have at this time on the topic area - bibliography
   - Known work plans for gathering future data
   - Key data gaps and uncertainties
   - Regulatory status
   - Initial summary messages.
2. **Document shared understanding and messages.** For each primary topic area, the Work Group would discuss the material compiled by the study group and develop a shared understanding of the status of the information. Meeting notes from these Work Group discussions would document:
   - Shared messages about the topic, for communication within member agencies and to stakeholders.
3. **Develop Overall Recommendations.** The Work Group would bring together the findings from each topic area into a comprehensive set of findings and problem statements. On that platform, the Work Group would brainstorm and then work to reach consensus on recommendations:
   - As discussed above under project purpose, these recommendations would be:

    - Recommendations for expectations regarding recontamination and source management at cleanup sites.
    - Recommendations regarding interim approaches.
    - Recommendations for completed cleanup sites that are recontaminating
    - Also recommend ideas for filling of data gaps and long-term solutions.
- Think about recommendations in terms of short term goals versus long term goals - first 20 years and the second 20 years
- "Short term goals" means near term expectation and actions that accelerate cleanups while addressing phthalate issue.
    - Recognize 2020 Puget Sound Milestone and timing of municipal NPDES.
- What can practically be accomplished.
- Important to manage expectations to policy people & community. Stress that the issue is in the very early formative stage.
- Important message to public and stakeholders include the timeline and short/mid/long term goals.
- Interim solutions focus on ability to make real progress in face of uncertainties and are stepping stones to completing end goals.
- Creating a structured process will help individual groups work within the larger picture.
- Look for precedent approaches for similar chemicals or for phthalates in other regions or internationally.
- Need immediate communication about the phthalate problem and the purpose of the Work Group as input to current projects and permit/regulatory process. Need to craft ongoing permit initiatives to not conflict with this process.

DRAFT WORK PLAN: see attached "Concept Diagram - Project Approach"

STAKEHOLDER INVOLVEMENT: WHO TO INVOLVE AND HOW TO INVOLVE THEM.

- Identify key stakeholders (agencies, citizens groups, regulated community, tribes, NGOs)
- Use existing project focus groups for idea exchange.
    - Foss – CHB forum.
    - Duwamish – DRCC
- Clarify to stakeholders that this is not a formal process and there will be no decision making, just development of shared understanding and recommendations for potential decision making.
- Keep public informed – clarify outcomes manage expectations.

- Public messages and documentation could come out of every Work Group meeting.
- Work Group could provide input to conference/poster sessions (SMARM, Puget Sound Initiative)
- ***Before the September 6 meeting, each Work Group participant should think about and get policy input on appropriate stakeholder involvement for further discussion in the work plan development***.

FUTURE DELIVERABLES AND MEETINGS

- ***Floyd|Snider to prepare a draft work plan*** (scope and schedule) for group review – target date August 25.
- ***Floyd|Snider to prepare a draft member charter*** for group review containing the agreed upon goals and working principles for the Work Group – target date Sept. 6 meeting.
- ***Work Group Meeting set for 9/6 8:30am-12:00pm in Tacoma*** (John O'Loughlin to arrange a meeting room)
  - Discuss detailed work plan
  - Discuss resources needed (staff commitment, potential consultant work, other $?)
  - Discuss draft Work Group Charter
- ***Work Group Meeting set for 9/27 8:30-12 at King County Offices***
  - Initial phthalate problem definition and public messages re: Work Group process
- Distribute work plan, charter and key messages to Policy Group for review following 9/27 meeting
- ***Schedule Work Group meeting with Policy Members in October*** – to receive input on these materials
- Floyd|Snider (Drew Hilen) to schedule the October Policy meeting, to be held in Tacoma
  - Target the 1st two weeks of the month. Not on Thursdays or Fridays – Tuesday or Wednesday would be best. Not 10/3 or 10/17-19
- Name of the group – At present the group has agreed to name itself the Phthalates Work Group. However, it recognizes that another name might be useful to better communicate its goals and structure

Phthalate Work Group Meeting Notes
September 6, 2006

ATTENDEES

John O'Loughlin	City of Tacoma	joloughl@cityoftacoma.org
Kris Flint	EPA	flint.kris@epa.gov
Bill Moore	WA Dept. of Ecology	Bmoo461@ecy.wa.gov
Kathryn DeJesus	WA Dept. of Ecology	Kbco461@ecy.wa.gov
Jeff Stern	King County	Jeff.stern@metrokc.gov
Bruce Tiffany	King County	Bruce.tiffany@metrokc.gov
Pete Rude	City of Seattle	Pete.rude@seattle.gov
Kate Snider	Floyd|Snider (facilitation)	kate.snider@floydsnider.com
Drew Hilen	Floyd|Snider	drew.hilen@floydsnider.com

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PURPOSE OF THE MEETING

This was the second meeting of the Phthalate Work Group. It took place in the Old Fire House building along the Thea Foss Waterway in Tacoma, WA. The purpose of the meeting was to develop concise and better working definitions of the Phthalate Work Group, while reviewing and commenting on the Draft Summary Piece, Work Plan Scope and Schedule, Letter of Agreement and Ground Rules.

AGENDA

- Review and Finalize 8/10 Meeting Notes
- Review and comment on the DRAFT Summary Piece
- Discuss stakeholder involvement
- Review and comment on DRAFT versions of the Work Plan and Schedule
- Review and comment on the DRAFT Letter of Agreement and Ground Rules documents.

REVIEW OF MEETING NOTES AND WORK GROUP LOGISTICS

Floyd|Snider will issue draft meeting notes. Work Group members should “reply to all” when providing comments. Floyd|Snider will finalize before the next Work Group meeting.

King County Work Group representation was clarified. Noel Treat will be King County’s policy level representative. Jeff Stern and Bruce Tiffany will be the consistent Work Group participants.

DRAFT SUMMARY PIECE COMMENTS

Some general language adjustments were made:

- “Practical” will be substituted for “implementable”, as we can not speak to administrative implementability.
- “Accumulation” or “Re-accumulation” will be considered for use instead of “recontamination”.
- “Puget Sound Region” will be used rather than “Puget Sound” to incorporate fresh water as well as marine sediments.

The introductory language from the Letter of Agreement will be used in place of the introductory language in the Summary document.

It will be noted that consensus based decisions need to include appropriate caveats, additional information, pro/cons, and all the “yes, but…” information which could affect administrative practicality.

It will be clarified that recommendations for filling data gaps and acquiring additional significant information will be outcomes of the Work Group effort.

The first bullet re: objectives will be edited to read “Define phthalate contamination concerns. Place understanding of phthalate concerns in perspective with other sediment environmental threats. Address occurrence, risks, sources and control options for phthalate contamination. ”

Language at the top of page 2 will be edited to read “…intent to consider ongoing regulatory initiatives such as the 2020 Puget Sound Initiative.”

These edits will be made to the document and distributed for Work Group review before the 9/27 meeting.

STAKEHOLDER COMMUNICATIONS

It is recognized that stakeholders include both active regulatory and interest groups as well as the larger community and audience. An initial list of key stakeholders includes:

- Other programs in EPA
- Other regulatory programs affected by Work Group recommendations

- Other jurisdictions responsible for storm and combined sewer outfalls
- Landowners and business contributing to storm water
- Interests groups: environmental, community, and business
    - Citizens for a Healthy Bay, Duwamish River Cleanup Coalition
- Tribal Governments and NRD Trustees
- Manufacturers of products containing phthalates

The Work Group needs to develop a Communications Plan that will address the following:

- Communication with Key Stakeholders and Interest Groups.
- Communication to Public
- Communication to Media
- Distribution and coordination of Work Group information

A Draft Communications Plan will be developed by a subcommittee of member public involvement staff, headed by Jennifer Kauffman of King County. Participants will include representatives from City of Seattle, City of Tacoma, King County and Ecology. ***The Draft Communications Plan will be available for Work Group consideration at the 9/27 meeting.***

The Work Group has the following goals for the Communications Plan:

- Clarify that the Work Group is an informal process developing recommendations only
- Clarify that this work is focused on phthalates in sediments
- Keep the Work Group meetings as closed, small group meetings of the members only
- Share information and messages developed by the Work Group frequently with key stakeholders
- Attempt to reach a shared awareness and understanding of phthalate sediment concerns with DRCC and CHB
- Get input from key stakeholders near the beginning – through interviews or a few “listening sessions” – could use an early session to introduce stakeholders to the Work Group objectives
- Messages distributed by the Work Group should be understandable by average person.

King County will initiate and manage this subcommittee. Floyd|Snider will send copies of existing Work Group materials to Jennifer Kauffman by Monday 9/11.

WORK PLAN COMMENTS

As each study area is discussed, there will be a “parking lot” for both the regulatory status and recommendations. These will be incorporated later on when developing comprehensive problem statements and recommendations.

The Communications Plan will be added to the Work Plan scope and schedule.

An additional deliverable will be added to the Work Plan which is production of a general overview of the regulatory requirements governing phthalates in discharges and sediments.

Responsibilities were defined for the study areas:

- City of Tacoma- Phthalate Occurrence
- King County- Risk and Receptors
- City of Tacoma- Phthalate Source Identification
- City of Seattle- Phthalate Source Control and Treatment

The schedule for the study area work will be adjusted to have appropriate sequencing given the work effort required for each study area. Prep time will be maximized given the sequencing of the presentation and discussion dates.

Before the next meeting, Work Group members should think in more detail about the specific scope and sequencing for the study area work.

LETTER OF AGREEMENT AND GROUND RULES

The draft Letter of Agreement and Ground Rules was distributed and skimmed.

Floyd|Snider will edit to incorporate changes that reflect relevant changes made to the Work Group Summary document.

Work Group members are asked to review and comment on the LOA and Ground Rules by 9/15.

9/27 WORK GROUP MEETING

Floyd|Snider will prepare the following documents for the 9/27 meeting:

- Revised Summary Piece
- Finalized 8/10 Meeting Notes.
- Revised Work Plan , Schedule and Diagram
- Revised Letter of Agreement and Ground Rules

The 9/27 meeting will be held at the King County King Street offices, from DREW COMPLETE

The agenda for the 9/27 meeting will include:

- Presentation and discussion of Communications Plan
- Discussion of Letter of Agreement and Ground Rules
- Review of other revised documents
- Agenda and prep for Oct 9 Policy meeting.

Sediment Phthalates Work Group Meeting Notes
September 27, 2006

ATTENDEES

John O'Loughlin	City of Tacoma	joloughl@cityoftacoma.org
Kris Flint	EPA	flint.kris@epa.gov
Bill Moore	WA Dept. of Ecology	Bmoo461@ecy.wa.gov
Kathryn DeJesus	WA Dept. of Ecology	Kbco461@ecy.wa.gov
Jeff Stern	King County	Jeff.stern@metrokc.gov
Bruce Tiffany	King County	Bruce.tiffany@metrokc.gov
Pete Rude	City of Seattle	Pete.rude@seattle.gov
Jennifer Kauffman	King County	Jennifer.kauffman@metrokc.gov
Kate Snider	Floyd|Snider (facilitation)	kate.snider@floydsnider.com
Erin Murray	Floyd|Snider	erin.murray@floydsnider.com

This meeting summary was prepared by Kate Snider and Erin Murray. It is based on a transcription of the flip charts used during the meeting to document the discussion. Action items are identified in ***bold script***.

PURPOSE OF THE MEETING

This was the third meeting of the Phthalate Work Group. It took place at the Department of Natural Resources and Parks in downtown Seattle. The purpose of the meeting was to develop concise and better working definitions of the Work Group, while reviewing and commenting on the Work Plan Scope and Schedule, Letter of Agreement, Ground Rules, and Draft Communications strategy.

AGENDA

- Presentation and discussion of Communications strategy
- Closure on Letter Agreement and Ground Rules, and other revised documents.
- Agenda and prep for October 9, 2006 Policy meeting.
- Resource Allocation for the Work Plan and level of effort expected for each entity.

COMMUNICATION PLAN DISCUSSION

Jennifer Kauffman of King County presented a Draft Communications and Outreach Strategy Plan and Outline. The draft communications strategy was developed for Work Group consideration by a subcommittee of public information specialists representing the Work Group entities including:

- Jennifer Kauffman, King County Wastewater Treatment Division
- Rob McNair-Huff, City of Tacoma Community Relations
- Curt Hart, Ecology Spills Program and Puget Sound Initiative Public Information
- Pat Serie, EnviroIssues, representing City of Seattle Public Utilities

COMMUNICATION STRATEGY DISCUSSION

The draft communication strategy was presented and discussed. Key points made in the discussion are listed below.

- The Work Group name should be changed to clearly define the project. The name chosen will be **Sediment Phthalates Work Group**.
- Good external two-way communications is a key goal of the project. The primary problem that has brought the Work Group together is that there is not currently a shared “universal understanding” of issues and concerns related to phthalates in sediments.
- One of the goals of the project is to get all of the Work Group members on the same page, and use that as a starting point for getting the media, environmental and community stakeholders at a similar level of shared understanding of the status of issues.
- The “shared messages” developed by the Work Group should be communicated out frequently. Stakeholder input on Work Group recommendations will be very important.
- Community and stakeholders need to be reminded frequently that the Work Group is not making decisions, and there will be formal public involvement in implementing recommendations if they require regulatory change.
- It is crucial to communicate clear messages regarding the goals and products of the Work Group in a clear and defined way:
    - The Work Group is not a decision making entity.
    - The Work Group is not “cutting deals” behind closed doors.
    - The Work Group is not making site-specific decisions.
    - The Work Group <u>is</u> trying to procure and summarize existing information to reach a shared understanding of the issue and come to reasonable recommendations.
- The Work Group members will produce messages in the course of their work together. Floyd|Snider will document the Work Group meetings including the shared messages developed in the Work Group process.

- Work Group members will describe the project, communicate messages and receive input as part of their "business as usual" in the community and in the existing forums that they are already engaged in relative to source control, water quality and sediment cleanup.
- The most important outreach to stakeholders can be done using the existing forums that many of the Work Group members and stakeholders are already involved in. As much as possible, this work should be an additional agenda item in those existing meetings.
- It makes sense to use these existing forums as a platform that will enable the Work Group to get their ideas/concerns out to the regulated community and public, and to receive input.
- The TAG (technical advisory group) forums (Citizens for a Healthy Bay, Duwamish River Cleanup Coalition) are particularly good groups to connect with. Does the scope of their EPA grants include participation and involvement in this process?
- Local health departments could be good to include as "go-to" references for broader issues regarding phthalates other than in sediments.
- Reporters and media should be added to the stakeholder list.
- Make sure this is not blown into too large and burdensome a process.

The public information specialists working on the communications strategy recommend that a communications consultant be engaged to assist with managing the communications process, developing materials and providing documentation.

- A communication "lead" is recommended to support the Work Group. The communications lead would:
  - Attend Work Group meetings
  - Manage the communications outreach process (make sure planned steps were implemented, track)
  - Document communications steps taken
  - Produce communications pieces using Work Group meeting summaries and products.
- The outreach process should be documented:
  - Steps taken for outreach should be documented
  - Information going out to the community should be well written and accumulated
  - Input received should be documented – at least as to the topics that input is provided on
  - The Work Group products will include a bibliography of sources used to compile information.

Floyd|Snider to develop targeted scope for communications plan and estimate for communications consultant.

Propose amendment to Floyd|Snider contract to include community plan implementation (through subconsultant). If scope and budget for this role is approved, Floyd|Snider would propose some alternative consultants for consideration.

Jennifer Kauffman to revise the Proposed Communications Strategy materials based on input from the group. This was done and the revised materials are attached to this meeting summary.

FINAL DISCUSSION ON LETTER OF AGREEMENT

The Letter of Agreement was approved for finalization.

Floyd|Snider to finalize and distribute by October 2. Work Group members and policy leads should review prior to October 9. Signature on October 9 would be great.

FINAL DISCUSSION ON SCOPE OF WORK AND RESPONSIBILITIES

The draft Scope of Work and schedule was reviewed again. The following was decided:

- Implementation of the Communication Plan will be added to the scope
- Ecology (Kathryn) will lead the development of a regulatory summary, with participation from EPA and Ecology staff.
- The scope needs to acknowledge that King County, City of Tacoma and City of Seattle are providing services to assist in filling data gaps. The Work Group recommendations may include other work to fill data gaps, which may be accomplished by these entities, likely overlapping with the Work Group process.
- The schedule was adjusted to change the sequence of the study area work.
- Two meetings will be held in November to discuss the "Occurance" study area. No meetings will be held in December given the holidays.

Floyd|Snider will update the scope and schedule to include these items.

Erin Murray to coordinate with Work Group members on their vacation time between now and the end of July. She will distribute the calendar to the group at the next meeting.

Following the October 9 meeting, additional Work Group meetings will be scheduled.

REVIEW OF PHTHALATE WORK GROUP RESOURCE ALLOCATION SPREADSHEET

Floyd|Snider produced a draft budget resource allocation spreadsheet as a starting point for discussion. The following adjustments were decided in discussion:

- Hours associated with the Work Group meeting process were initially estimated to just include meeting time. These hours will be doubled to include work between meetings.
- Ecology and EPA hours will be adjusted for the regulatory summary.

- King County hours will be increased to cover participation by two work group members.
- The hours assumed for the research and presentations for the study areas were judged to be light for both the lead and participating entities.

Bruce Tiffany will coordinate with King County, City of Seattle and City of Tacoma members to better define the scope and level of effort required for each study area.

Floyd|Snider will update the resource spreadsheet to reflect these changes.

OCTOBER 9 POLICY MEETING IN TACOMA

The October 9th Meeting will be held at the Thea Foss Waterway Old Fire Station in Tacoma from 10-12am.

AGENDA

1. Scope Description
2. Work Plan
3. Communication Plan
4. Funding and Staff Resources
5. Letter of Agreement

Kate will be prepared to present an overview of the materials, and lead the meeting.

Sediment Phthalates Work Group and Policy Member Meeting Notes
October 9, 2006

ATTENDEES

John O'Loughlin	City of Tacoma	joloughl@cityoftacoma.org
Karen Larkin	City of Tacoma	klarkin@ci.tacoma.wa.us
Kris Flint	EPA	flint.kris@epa.gov
Lori Cohen	EPA	cohen.lori@epa.gov
Bill Moore	WA Dept. of Ecology	Bmoo461@ecy.wa.gov
Kathryn DeJesus	WA Dept. of Ecology	Kbco461@ecy.wa.gov
Jim Pendowski	WA Dept. of Ecology	jpen461@ecy.wa.gov
Janice Adair	WA Dept. of Ecology	jada461@ecy.wa.gov
Jeff Stern	King County	Jeff.stern@metrokc.gov
Bruce Tiffany	King County	Bruce.tiffany@metrokc.gov
Pete Rude	City of Seattle	Pete.rude@seattle.gov
Martin Baker	City of Seattle	martin.baker@seattle.gov
Kate Snider	Floyd|Snider (facilitation)	kate.snider@floydsnider.com
Erin Murray	Floyd|Snider	erin.murray@floydsnider.com

This meeting summary was prepared by Kate Snider and Erin Murray. It is based on a transcription of the flip charts used during the meeting to document the discussion. Action items are identified in ***bold script***.

PURPOSE OF THE MEETING

This was the fourth meeting of the Sediments Phthalates Work Group and second of the meetings involving the policy members. It took place at the Thea Foss Waterway Old Fire Station in Tacoma. The purpose of this meeting was to present the policy members with Work Plan documents and discuss commitment to and funding for the project.

AGENDA

- Presentation of the Scope and final review
- Presentation of the Work Plan and final review
- Presentation and discussion of Communications strategy
- Discussion of funding and staff resources
- Review and signing of the Letter of Agreement

COMMUNICATION STRATEGY DISCUSSION

The draft communication strategy was presented and discussed. Key points made in the discussion are listed below:

- The press and community leaders are interested in the formation and purpose of the Work Group. It is very important to get the message out soon about the objectives of the Work Group—stressing the advisory and collaborative problem-solving nature of the group. The member organizations are working together to define the scope of the problem, and determine how to tackle the issues.

Floyd|Snider to develop 1-page summary of talking points that can be used by Work Group member organizations to help deliver the message about Work Group purpose within their organizations and to the community. These talking points should also describe the types of recommendations that the Work Group is likely to develop.

- Discussed further the idea of using existing forums that many of the Work Group members and stakeholders (e.g., Citizens for a Healthy Bay, Duwamish River Cleanup Coalition) are already involved in as a platform for getting our ideas out to the regulated community and public. The goal is to get phthalates as an additional agenda item in those existing meetings.

Communications Lead

In lieu of a consultant, Jim Pendowski suggested a new hire at Ecology that could step in to the role as the Work Group's communications lead. This individual will be working ½ time with the Toxics program and, therefore, will have sufficient time to devote to the Work Group and phthalate issue at hand.

- It was shared agreement among the attendees that an agency person would be best suited as the communications "point person".

Floyd|Snider to coordinate with Kathryn on the specifics of coordinating with this individual as the Communications Lead.

- This individual needs to know and be in contact with Public Information personnel for all of the member organizations.
- It is expected that he/she will have sufficient time to get educated and "up to speed" on phthalates and the goals of the Work Group.
- This "point person" would attend all meetings, prepare the Work Group with materials, track and document outreach activities.
- It is going to be important to track the communications process closely to ensure we have enough/right resources for the task.
- The formal spokespeople for each organization are the policy leads.

Floyd|Snider will adjust the scope in Section 6.1 and the resource allocation to identify Ecology as providing the Communications Lead.

CLARIFICATIONS ON INFORMATION REVIEW FOR TECHNICAL STUDY AREAS

- For compilation of data within each defined study area, the lead will request existing information from all the Work Group members, and other available sources, develop a bibliography, and present to the group to develop shared understandings on the topic.
- The information presented will not be "new" but will be compiled by integrating multiple sources and data from existing studies.
- Additional data generated from continued sampling and pilot studies will be incorporated.
- There are opportunities to coordinate with Puget Sound Partnership, especially regarding their air deposition study.
- It is recognized that there are information sources from other geographic locations that can be used to add insight and information relative to Puget Sound.
- The Work Group members will perform "peer review" for the presented information during the process of review and discussion.

COMMITMENT TO PROJECT

- The estimated consulting fee for the project is $68,000.
- Ecology will provide a total of $50,000.
- King County, the City of Tacoma and City of Seattle will each contribute $6,000 to cover the remaining balance.
- The City of Tacoma will be responsible for contracting the work, and will invoice the member organizations for their contributions.
- The Letter of Agreement was signed by all member organizations.

Sediment Phthalates Work Group Meeting Notes
November 29, 2006

ATTENDEES

John O'Loughlin	City of Tacoma	joloughl@cityoftacoma.org
Kris Flint	EPA	flint.kris@epa.gov
Bill Moore	WA Dept. of Ecology	Bmoo461@ecy.wa.gov
Kathryn DeJesus	WA Dept. of Ecology	Kbco461@ecy.wa.gov
Jeff Stern	King County	Jeff.stern@metrokc.gov
Bruce Tiffany	King County	Bruce.tiffany@metrokc.gov
Pete Rude	City of Seattle	Pete.rude@seattle.gov
Seth Preston	WA Dept. of Ecology	spre461@ecy.wa.gov
Kate Snider	Floyd|Snider (facilitation)	kate.snider@floydsnider.com
Erin Murray	Floyd|Snider	erin.murray@floydsnider.com

This meeting summary was prepared by Kate Snider and Erin Murray. It is based on a transcription of the flip charts used during the meeting to document the discussion. Action items are identified in ***bold script***.

PURPOSE OF THE MEETING

This was the sixth meeting of the Sediments Phthalates Work Group. It took place at the Thea Foss Waterway Trailer in Tacoma. The purpose of this meeting was to reach agreement on and document the key messages that are apparent from the material collected and reviewed regarding the occurrence of phthalates.

AGENDA

- Distribution of the disclaimer for use on Work Group products
- Distribution of updated Occurrence figures from Ecology
- Discussion on Work Group products and public availability
- Occurrence discussion and messages
- Discussion of Talking Points regarding this project

DISCLAIMER AND PUBLIC AVAILABILITY OF WORK GROUP PRODUCTS

- Disclaimer language below has been agreed to by the group.

  This information on sediment phthalates represents a preliminary, limited collection of existing information. It is intended solely for use and discussion within the Sediment Phthalates Work Group for informational purposes.

  The information has been drawn from published and unpublished sources. A comprehensive analysis or validation of all this information has not been completed and no conclusions have been made to date.

- This disclaimer should be included on all information gathering products (i.e., on the cover, summary sheets and summary spreadsheets)
- Notebooks compiled of information gathered, with summary spreadsheets should stay within Work Group. They should not be distributed widely within member organizations or to others, as there has been no formal QA/QC on the information.
- Lists of the references used can be shared outside the Work Group membership.
- The key messages that are documented from Work Group meetings as apparent from the material collected and reviewed can be shared publicly, with the information references attached.
- Work Group members can update their information notebooks as appropriate—it is just important to note that there has been no formal QC of the information.

Floyd|Snider to send the disclaimer electronically to Work Group.

KEY MESSAGES RE: OCCURRENCE IN ENVIRONMENT AND PATHWAYS TO SEDIMENTS

This is a summary of the key messages or conclusions agreed to by the full Work Group as being apparent from the information gathered and discussed relative to occurrence of phthalates in the environment. The information used to generate these messages is listed on the attached Reference List.

General

Phthalates are ubiquitous in the urban/developed environment, in air, surface water and sediments.

Occurrence in Air

- Air deposition of DEHP on watershed surface is magnified by transport from a wide deposition area to a smaller sediment area (this is key to final accumulation in sediments).
- DEHP and BBP occur more in the particulate phase in air and these are the two phthalates that are most found in sediments.

- Occurrence in air on particles is significant because phthalates that occur in air are deposited to the watershed surface, which then runs off to the sediments.
- Deposition on impervious surfaces within the whole watershed is meaningful to sediment accumulation.
- The level of permeability and infiltration characteristics of the watershed greatly affects transport of phthalates to sediments.
- Indoor air has much more concentrated DEHP than outdoor air.
- The sources of phthalates in air are widely distributed.

Occurrence in Surface Water Runoff

- Occurrence in surface water tends to be near urban areas.
- Not much variability within region—DEHP concentrations typically between 0.5—5 ppb.
- Phthalates in surface water tend to be related to urban influences (they are very low in highly rural top of watershed areas).
- Phthalates tend to accumulate on particulates and these particulates end up in surface water.
- Not seeing phthalates as significantly in the dissolved phase.
- Surface water data is more representative of the big picture (composite water samples more homogeneous than focused sediment samples).
- Air deposition and surface water both transport phthalates to sediments where they concentrate over time.
- Phthalates tend to remain fairly local within the area of contamination—they are not in as high concentrations in rural surface water sources.
- Phthalates are found in all ambient water bodies in developed areas.

Occurrence in Marine Sediments

- Data reviewed is focused on Ecology sediment sites and ambient monitoring program (PSAMP).
- Data summarized by Ecology is less than 10 year old data with detects only:
  - 16% above SQS DEHP, many more data points for DEHP—Dry weight
  - 33% above SQS BBP—Dry weight
- Recent cleanup site data allowing “time 0 evaluation” is available from the Thea Foss and Norfolk as well as Diagonal /Duwamish sites in the Lower Duwamish
  - Balance of variables are uncertain and different in each site
  - However, various amounts of accumulation in very short order (less than 5 years) to levels of concern

- At these locations it looks like rapid accumulation of phthalates in sediments (after cleanup) is associated with urban stormwater outfalls:
  - In the local area of the outfall.
  - In low-energy environments.
- Small loading inputs discharging to a low energy basin or a large input (large drainage basin and/or large source input) to a low or high energy environment can (and do) cause rapid accumulation in sediments.
- In these environments accumulation occurs and exceeds SQS within just a few years.
- Accumulation depends on the:
  - Size of input
  - Energy of receiving environment
- Variables
  - Character of watershed
  - Character of receiving environment

Occurrence in Fresh Water Sediments

- Widespread presence
- The key differences between occurrence in fresh and marine sediments relates to the differences in receiving environments.
- There are similar characteristics of phthalates in discharges because freshwater and marine environments have similar watershed characteristics.
- A main difference between fresh versus marine is the difference in receptors - degradation, etc.

Occurrence in Wastewater (POTW information, not single industry discharges)

- Wastewater effluent phthalate concentrations are similar to surface water runoff concentrations.
- Wastewater influent is higher in phthalates than surface water runoff.
- POTW influent is higher in phthalates than POTW effluent.
- Wastewater influent seems to be measurably higher in new residential areas than older residential areas or industrial areas (phthalates seem to be associated with people and newly constructed surfaces).

Occurrence in Other Sediment Types (catch basins, sediment traps)

- Central tendency of catch basin/sediment trap sediments almost always above regulatory sediment standards SQS (which are not applicable at the catch basins).

  * Data sets biased (data exists primarily for Lower Duwamish and Foss where there are sediment concerns).
  * However, catch basins are located throughout these urban developed basins which should be fairly representative.
- Assume that these characteristics of in-line sediments are likely representative of most urban watersheds.
- Urban soil generally higher than rural (correlates to air deposition).

ITEMS FOR PARKING LOT OF ISSUES FOR FURTHER DISCUSSION

As the messages above were being discussed, items were identified for further research or discussion in subsequent Work Group meetings. These items are listed below. This "parking lot" of issues will be added to in future informational meetings.

- Comparative risk issues.
  * Indoor air and car air greater risk/occurrence than sediment risk/occurrence.
- Consider recommendation to have air agencies/lobbyists look more closely at air risk and the pathway to sediments and related standards.
- Consider evaluating whether more data from outfalls adds to dissolved versus particulate occurrence conclusions.
- Consider development of a diagrammatic figure illustrating the fate and transport of phthalates in the environment.
  * Consider doing some mass balance.
  * The affect of water concentrations to sediment concentrations—what concentrations and phase in surface water are we concerned about regarding affect to sediment? This is a hard question because of modeling difficulty.
- Address persistence.
- Consider further the presence of phthalates in wastewater from industrial areas versus new construction residential areas.
- Consider combined versus separated storm drains.
- Consider NPDES Industry Discharge of phthalates.
  * Phthalates are not an analyte regulated in most NPDES permits, but there may be data in applications.
- Direct discharge marinas, shipyards, etc. Marinas can have un-permitted direct discharges and use many new construction materials—this could be significant.
  * Consider marinas for source ID sampling.
- Consider investigating marine construction as a possible source.
- Consider soil concentrations adjacent to large roads.
- Consider correlating catch basin concentrations to % impervious, land use and air deposition for the watershed.

- Is there phthalate catch basin data from Bellingham Bay TMDL Study?
- Do phthalates exist in sediments in the form of abraded plastic/plastic pieces?
- What do we know about the phthalates breakdown (does plastic rope in marinas affect sediment?)
- Consider evaluating watersheds tributary to Ecology sediment site information with air photos—examine watershed characteristics and linkage of phthalates to urban runoff:
    - % impervious
    - Roadway use
    - Land use type
- Not much background sediment data regarding phthalates—consider acquiring and evaluating (relative to land use).
- Re-evaluate sedqual information—including non detects.
- Consider evaluation of historical trends as possible regarding recent increase in phthalates use and sediment concentrations

Sediment Phthalates Work Group Meeting Notes
January 31, 2007

ATTENDEES

John O'Loughlin	City of Tacoma	joloughl@cityoftacoma.org
Kris Flint	EPA	flint.kris@epa.gov
Bill Moore	WA Dept. of Ecology	Bmoo461@ecy.wa.gov
Kathryn DeJesus	WA Dept. of Ecology	Kbco461@ecy.wa.gov
Jeff Stern	King County	Jeff.stern@metrokc.gov
Bruce Tiffany	King County	Bruce.tiffany@metrokc.gov
Pete Rude	City of Seattle	Pete.rude@seattle.gov
Seth Preston	WA Dept. of Ecology	spre461@ecy.wa.gov
Kate Snider	Floyd|Snider (facilitation)	kate.snider@floydsnider.com
Erin Murray	Floyd|Snider	erin.murray@floydsnider.com

This meeting summary was prepared by Kate Snider and Erin Murray. It is based on a transcription of the flip charts used during the meeting to document the discussion. Action items are identified in ***bold script***.

PURPOSE OF THE MEETING

This was the seventh meeting of the Sediments Phthalates Work Group. It took place at the King County Department of Natural Resources and Parks. The purpose of this meeting was to reach agreement on and document the key messages that are apparent from the material collected and reviewed regarding sources of phthalates to sediments.

AGENDA

- Discussion on public process
- Discussion and finalization of 11/29/06 Occurrence meeting notes
- Development of key messages on Sources

GENERAL

Seth to research getting a page on Ecology's website that will hold the Work Group's final publicly available documents so they can be accessible to all.

Some Work Group members are attending a Source Control meeting on February 1, 2007 and will distribute all the publicly available documents produced by the Work Group thus far.

On March 20, 2006 Government, Management, Accountability and Performance (GMAP) is holding a meeting on stormwater toxics. This would be a good forum to discuss the Sediment Phthalates Work Group and our process.

Seth is keeping a log of public outreach conducted for the project.

Floyd|Snider to finalize 11/29/06 meeting notes and distribute to Work Group and Policy members.

KEY MESSAGES RE: SOURCES OF PHTHALATES IN ENVIRONMENT TO SEDIMENTS

This is a summary of the key messages or conclusions agreed to by the technical Work Group as being apparent from the information gathered and discussed relative to sources of phthalates in the environment. The information used to generate these messages is listed on the attached Reference List.

Phthalates are a key commodity in the U.S. and throughout the rest of the world.

- The quantity of phthalates in our environment is measured in billions of pounds—important to clearly illustrate all of the common products that contain plasticized PVC.

Significant quantities of phthalates are manufactured in the U.S. and imported to the U.S.

- There is a significant presence in imported products. Worldwide production appears to be increasing. Need to recognize this when thinking about potential source control alternatives.

The primary use of phthalates is in plasticized PVC products, which can contain a significant percentage of phthalates by weight (up to 40%). Plasticized PVC products clearly contain the largest reservoir of phthalates in the environment.

- Off-gassing from plasticized PVC products is not the only source of phthalates in the environment, but is by far the greatest.
- There are a wide variety of plastics present in the environment; however, for phthalates the focus is on flexible PVC that has plasticizers added to it.
- Plasticized PVC is used widely as a construction material (vinyl flooring, electrical cable covering, carpet, shower curtains, etc). Ubiquitous in construction building materials.

- Plasticized PVC is very inexpensive and versatile, which is why it is so prevalent. There is a huge economic incentive for its use worldwide, which provides a barrier to substitution.
- It appears that DEHP is a good surrogate to use in this evaluation for the whole class of phthalates seen in sediments - DEHP is the predominant phthalate used to plasticize PVC (it appears to make up at least 50% of the phthalates used).
- There is a huge reservoir of phthalates currently out in the environment in the form of plasticized PVC products—there is constant off-gas loading to air from these products throughout the life of these products (approximately 1–50 years of product life). Therefore, if product restrictions or alterations were made to reduce future loading, this reservoir of source would still be uncontrolled.
- Autos are a significant source of plasticized PVC (as well as the largest source for particles in urban air that influence the equilibrium of phthalate off-gassing).

It is well documented that all plasticized PVC products off-gas DEHP to the air over long periods of time (over the life of the flexibility of the products).

- Rigid PVC has not been plasticized with phthalates to appreciable extents and thus is not a primary source of phthalates to the air or sediments—it either does not off-gas or off-gasses at an extremely low rate.
- Off-gassing is driven by environmental variables that affect mobility (temperature; particulate concentration in the air; and concentration of phthalates in the plasticized PVC). As the amount of particles in the air increases, off-gassing is increased through equilibrium balance.
- The concentration of phthalates in plasticized PVC ranges up to 40% by weight (e.g., vinyl flooring is approx. 20% phthalates by weight).
- It is well documented that off-gassing from plasticized PVC to the air is the primary source of DEHP in the environment.

It is well documented that DEHP in air attaches to dust and other particles in the air.

- Vehicles are the biggest source of fine particles in the urban environment.
- DEHP is also soluble in oil and is present in waste oils.

For the sediment pathway, phthalates in outdoor air that are attached to particles are a key concern.

- Although the total of human health exposures include many other pathways (indoor air, cosmetics, ingestion, etc.), our focus is on the sediment pathway.
- It is important to note that indoor and outdoor air are constantly exchanging, which makes them a likely source of phthalates and particulates to each other.

Phthalates are brought to the ground by rain and particle deposition.

- Phthalates deposited on impervious surfaces may then be transported to the sediments with storm water runoff, where they are deposited in sediments at the end of the pipe..

- Watershed and “airshed” characteristics significantly influence the amount of phthalate contribution and the balance of sources contributing to sediments.
- Auto sources are influenced by the amount of particles in the air and amount of plasticized PVC in cars, as well as other auto sources (tires, brake pads, etc.).

There are other sources of phthalates (such as wear from tires, etc.) but atmospheric deposition appears to be the most significant source of phthalates to sediments.

- Particulates laden with phthalate from automotive sources that end up on impervious areas may be a key source to sediments.
- Another sediment source of phthalates is wastewater contribution from combined sewer overflows (CSOs). Some products contribute to this that do not contribute to air deposition (e.g., personal care products). However, these products appear to be a very small percentage of the phthalate loading to sediments. Wastewater is a small percentage of loading to sediments and this is the pathway through which personal care products would enter sediments.

Source tracing may identify specific point sources of phthalates from manufacturing or handling that can be controlled, but non-point air deposition sources appear to be the most significant sources.

- The information reviewed indicates that nationally the amount of material that could contribute to direct release through production and handling is a small percentage of the total DEHP budget in the environment.
- Release to the environment appears to predominantly come from off-gassing of end-use products and not from the production and manufacturing of products containing plasticized PVC.

All of the sources of phthalates are aggregated in sediments.

PARKING LOT

The following items are additions to the “parking lot” of items identified for potential further evaluation or consideration by the Sediment Phthalates Work Group during deliberation on the issues.

- Consider ways to illustrate the enormous range of common products that are manufactured from plasticized PVC, in order to give the general public an understanding of the prevalence of phthalates in our environment.
- Consider analogies that can be made between the volume of phthalates in our environment and other products that are more commonly understood. Work on ways to illustrate the scale/magnitude of sources.
- Consider making a diagram that illustrates use/sources of phthalates versus pathways for exposures - illustrating human health versus sediment end points.
- Provide perspective in recommendations on the proportion of relative exposure mechanisms.

- More work could be done on mass balance of relative source contributions:
  - Source testing and mass balance seems to indicate that tires and brake pads are a minor source of phthalates when compared to plasticized PVC off-gassing.
- Consider suggestions for studies to further evaluate auto sources.

Sediment Phthalates Work Group
Technical Committee Meeting Notes
February 15, 2007

ATTENDEES

John O'Loughlin	City of Tacoma	jolooughl@cityoftacoma.org
Kris Flint	EPA	flint.kris@epa.gov
Bill Moore	WA Dept. of Ecology	Bmoo461@ecy.wa.gov
Kathryn DeJesus	WA Dept. of Ecology	Kbco461@ecy.wa.gov
Jeff Stern	King County	Jeff.stern@metrokc.gov
Bruce Tiffany	King County	Bruce.tiffany@metrokc.gov
Richard Jack	King County	Richard.Jack@metrokc.gov
Pete Rude	City of Seattle	Pete.rude@seattle.gov
Seth Preston	WA Dept. of Ecology	spre461@ecy.wa.gov
Kate Snider	Floyd|Snider (facilitation)	kate.snider@floydsnider.com
Erin Murray	Floyd|Snider	erin.murray@floydsnider.com

This meeting summary was prepared by Kate Snider and Erin Murray. It is based on a transcription of the flip charts used during the meeting to document the discussion. Action items are identified in ***bold script***.

PURPOSE OF THE MEETING

The purpose of this meeting was to reach agreement on and document the key messages that are apparent from the material collected and reviewed regarding the risks and receptors of phthalates to sediments.

AGENDA

- Finalize 1/31 meeting notes.
- Schedule update and confirmation.

General Points

- Outreach process emphasis needs to clarify our focus on phthalate in <u>sediments.</u>
- Human health concerns regarding phthalates in products and environmental matrices (other than sediments) are certainly a concern, but not the focus of this sediment group.

KEY MESSAGES - RISK AND RECEPTORS FOR PHTHALATES IN SEDIMENTS

Toxicity/Carcinogenicity of Phthalates Relative to Other Compounds

- Although phthalates are in the same class as PCBs and pesticides (DEHP—Class B2 Probable Human Carcinogen; BBP—Class C Possible Human Carcinogen), they are much less potent with respect to cancer risk than PCBs and other semi-volatile organic compounds (SVOCs).
- The potential for endocrine effects attracts a lot of attention; however, endocrine effects are not well studied. The data that exists suggests DEHP and BBP are several orders of magnitude less potent than other endocrine disruptors found in the environment.
- The ATSDR DEHP toxicity profile is useful in describing phthalate human health risk.
- Phthalates have not been a focus for bioaccumulation studies because they do not readily bioaccumulate (they are primarily metabolized).
- Two identified studies calculated biota-sediment accumulation factors (BSAFs) for phthalates. Both had results much less than 1. A value of 1 or greater is cause for concern.
- Phthalates dropped off Ecology's persistent, bioaccumulative, and toxic compound (PBT) list because they do not bioaccumulate to a great enough extent to be included.
- So far as we know, phthalate metabolites (breakdown products) do not have significant risk.
- DEHP (the most common phthalate of concern for sediments) is not a common phthalate in personal care products (Koo paper).
- Phthalates in personal care products may be a concern for human health based on direct contact exposure, but are different from the phthalates that we see in sediments.
- Would like to see figures depicting phthalate carcinogenicity and toxicity in comparison to other key sediment contaminants.

Human Health Risk—Phthalates in Sediments

- The Lower Duwamish Study concludes that for high-end estimates of subsistence level tribal seafood consumption, phthalate human health risk just exceeds lower threshold of concern estimate by USEPA ($1x10^{-6}$). Phthalate risk is $6x10^{-6}$, in the Duwamish, whereas PCBs, for comparison are almost 3 orders of magnitude higher ($2x10^{-3}$). Risks from toxic effects are below thresholds (hazard quotients [HQs] less than 1).
- For this subsistence-level exposure scenario, the cancer risk from phthalates represents only 2 percent of the total excess cancer risk a consumer could get from consuming seafood from the Duwamish.

- To note—the group did not find other CERCLA type risk assessments that addressed phthalates, apparently because they have lower risk than other common pollutants and because they often occur with more toxic compounds at most sites.
- Lower Duwamish human health risk assessment uses fish tissue concentrations as a starting point. Both water and sediment concentrations affect fish tissue concentrations, but the relationship between concentrations in sediment and concentrations in fish tissue is hard to tie down. This is a key issue in determining whether to target sediment or water if fish tissue concentrations create unacceptable risk.
- For the Lower Duwamish, the surface weighted average sediment concentration (SWAC) for DEHP is 380 ppb (0.4 ppm), and for BBP is 45 ppb (0.05 ppm).
- Exposure to phthalates through direct contact with sediments containing phthalates did not generate unacceptable risk in the Lower Duwamish risk assessment. This was true for the most exposed population, tribal net fishers, and for beach play scenarios. This is primarily due to the fact that ASTDR shows that uptake of phthalates through the skin is low.

Sediment Quality Standards

- Sediment phthalate concentrations are not driving human health risk at the Lower Duwamish site; however, they are a risk to benthic invertebrates at some locations.
- Both Commencement Bay Sediment Quality Objectives (SQO) and the numeric Sediment Management Standards (SMS) are based on ecological (benthic) apparent effects—not human health.
- SMS numeric chemical criteria for phthalates are based on apparent effect thresholds (AETs) established by a series of acute and chronic effects biological tests including benthic infaunal abundance, larval abnormality and mortality, and amphipod mortality.
- The Sediment Quality Standards (SQS) correspond to a sediment quality that will result in no adverse effects to biological resources. The Cleanup Standard Level (CSL) is a less stringent standard than the SQS and is the threshold for minor adverse effects.
- Therefore, phthalate SQS and CSL numeric criteria were established for the protection of ecological health. The SMS also provides a narrative standard for the protection of human health, which must comply with Washington State Model Toxics Control Act (MTCA) human health risk levels.
- In the SMS, biological testing is provided to confirm sediment quality and overrides chemical results. Passing biological tests as described in the SMS overrides analytical chemical results that are above numeric criteria and serves as a site-specific demonstration of no apparent effects to the benthic community. Conversely, failing bioassay tests constitutes standards violations even when chemical tests results pass.

- The assumption behind the SMS numeric criteria for ecological risk is that by adversely affecting the benthic community, phthalate concentrations in the sediment have an effect on the larger ecosystem it supports. Although BSAF (biota-sediment accumulation factor) models are currently used, we do not completely understand the mechanisms well to make a direct correlation between sediment contamination concentrations and fish tissue contaminant levels.
- Important to note that in the SMS, protection of human health is a narrative requirement (evaluation is site-specific).
- Different risks and exposure pathways are evaluated with different methods and input data:
    - Benthic Community effects—comparison of sediment concentrations to SMS numeric standards that are based on benthic effects testing and AETs.
    - Benthic Community effects—bioassay testing–toxicity “pass” per Ecology guidance can trump SMS numeric chemical standards.
    - Human Health—site specific human health risk assessments utilizing site specific consumption and dermal contact assumptions (utilize fish tissue and sediment concentration data).
    - Ecological—site specific ecological risk assessments (using tissue and sediment concentration data).
- Several other sediment quality values (SQVs) have been developed for phthalates, but besides Washington State’s SMS, they are mainly just for DEHP. For marine sediments, SQVs are either based on AETs or probable effects levels (PELs). For freshwater sediments, SQVs have also been based on equilibrium portioning.
- These SQV are all meant to predict benthic community effects. In Washington, there are exceedances of these values in some of the sediment samples—mainly in urban areas. Results do not tend to be very different from SMS.

Risk and Receptors in Sediments

- The Lower Duwamish studies confirm that if SQS sediment concentrations for phthalates are met, sediments will be protective for all other exposure scenarios and receptors (including human health).
- Lower Duwamish studies do not indicate sediment effects to fish & wildlife, or human health due to the presence of phthalates. Suggests other urban and industrial sites unlikely to reach levels of concern for these receptors.
- At most sediment cleanup sites, phthalates appear coincidentally with other compounds, which tend to drive risk and cleanup. Consequently, phthalates are not typically identified in Records of Decision (RODs) because they are overshadowed by other, risk-driving contaminants.
- Sediment phthalates are a recontamination concern, which underscores both phthalates’ widespread presence and the rapid reaccumulation to levels of concern for benthic effects. Recontamination is not expected to cause risk to birds, fish,

mammals or human health, as the original cleanup conditions (with 100 years of accumulation) have not reached levels of concern for these receptors.

- Sediment recontamination by phthalates should be expected in urban environments with watershed and receiving environment characteristics typified by significant impervious runoff and depositional environments at outfalls.
- It is hard to separate sediment from water risk in an aquatic environment; however phthalates are not easily found in dissolved phase (water) because of their strong affinity for particles.
- Phthalates, however, are different from other chemicals with an affinity to sediments because they typically metabolize and thus, only weakly bioaccumulate (similar to PAH).
- Phthalates have a fairly high degradation rate (when compared to other chemicals) in air, soil, and water. In part, this is because they are easily metabolized.
- Phthalates persist much longer in soils and sediments than in water or air.

Relative Risk

- Consider development of calculations and/or diagrams that show relative importance of different human exposures to phthalates (e.g., sediments, inhalation of ambient indoor or urban air, etc.). Link to exposure and source diagram that has been discussed in previous meetings.
- Exposure and Source Diagram should be developed that illustrates multiple sources and exposure pathways—exposure from phthalates in sediment is very small part of the full picture.
- Relative exposure pie chart type diagram should be developed that illustrates:

  All phthalate exposure – DEHP/BBP percentage – percentage of DEHP/BBP from sediment and fish tissue

PARKING LOT

- Put phthalate concern in perspective with other sediment contaminants.
- Put phthalate risk in sediments in perspective with other phthalate pathways.
- Generate a table relating conclusions regarding phthalates to other chemicals.
- Acknowledge ‘apples and oranges’ issue regarding comparing CERCLA risk assessment with other human health risks of phthalate exposure.

Sediment Phthalates Work Group
Technical Committee Meeting
Source Control and Treatment
March 23, 2007

ATTENDEES

John O'Loughlin	City of Tacoma	joloughl@cityoftacoma.org
Kris Flint	EPA	flint.kris@epa.gov
Bill Moore	WA Dept. of Ecology	Bmoo461@ecy.wa.gov
Kathryn DeJesus	WA Dept. of Ecology	Kbco461@ecy.wa.gov
Jeff Stern	King County	Jeff.stern@metrokc.gov
Bruce Tiffany	King County	Bruce.tiffany@metrokc.gov
Pete Rude	City of Seattle	Pete.rude@seattle.gov
Seth Preston	WA Dept. of Ecology	spre461@ecy.wa.gov
Beth Schmoyer	City of Seattle	beth.schmoyer@seattle.gov
Kate Snider	Floyd|Snider (facilitation)	kate.snider@floydsnider.com

This meeting summary was prepared by Kate Snider. It is based on a transcription of the flip charts used during the meeting to document the discussion. Action items are identified in ***bold script***.

PURPOSE OF THE MEETING

The purpose of this meeting was to reach agreement on and document the key messages that are apparent from the material collected and reviewed regarding the source control and treatment of phthalates as it relates to sediment contamination.

AGENDA

Additional Information

Primary Source Control

- Bans
- Alternatives
- Reduction of off-gassing

Secondary Source Control and Treatment

- Removal from air
- Street cleaning
- Stormwater treatment and BMPs
- Chemical water treatment
- Bio water treatment
- Low impact drainage—increase permeability TSS effect

ADDITIONAL INFORMATION

- Beth provided additional information on treatment system costs.
- ***Jeff to find other cost information included in stormwater manual update.***
- ***Beth to pull Ecology cost information off website to see how relevant and best to present.***
- ***Beth to receive additional info regarding Port of Seattle Seatac treatment system cost and expected maintenance.***

SOURCE CONTROL AND TREATMENT—KEY MESSAGES

Primary Source Control—Bans

- A national ban on phthalates as plasticizers could potentially be effective in the long term; however, it does not seem that local bans would be effective in terms of pathways to sediments or sediment impacts over the next several decades due to the reservoir of material in the environment and its continued release of DEHP.
- Local bans don't address the significant amount of product generated nationally and internationally.
- Bans have the most potential to be effective for special products and human health pathway (e.g., medical and toys). These represent only a small volume of the plasticized PVC that contributes phthalates to sediments and thus limit the potential effectiveness of bans.
- Potential incentives could be useful in limiting the use of plasticized PVC, such as Leadership in Energy and Environmental Design (LEED) certification, Envirostars or "certified non-toxic." Plasticized PVC was recently reviewed by LEED but the decision was made to not currently address it.
- All the information considered indicates that phthalate loading to the environment is directly tied to population growth—quantity of materials will increase with more uses and more products. Future challenges will likely be bigger than those we have now.

Primary Source Control—Substitution and Coatings

- Alternative plasticizers—many present similar or worse environmental problems than phthalates.
- Phthalate alternatives are generally more expensive and not as versatile: they may be less toxic, although we do not know for sure.
- Overall, there is very little data regarding coatings that would reduce off-gassing from phthalate-plasticized PVC.
  - Medical applications show the most focus on phthalate substitutes and minimizing direct tissue exposure. Coatings for plasticized PVCs in medical applications are not likely viable controls for phthalate paths to sediments.
- Sediment endpoint for phthalates in the environment will likely require focus on construction materials and the construction industry, which is a heavy user of plasticized PVC.

Bans and Substitutions—Motivation

- Need to understand what drives society and what directly or personally affects individuals in order to motivate change.
- Direct effect of phthalates in sediments to society appears relatively small.
- Changes required to make a difference to phthalate concentrations in sediments would need to be at the national or international level.
- There are not any good precedents for sediment quality as a driver for a ban on phthalates.
- Phthalate reductions motivated by human health direct exposure (medical apparatus, toys, cosmetics) could potentially develop and publicize information about production substitutes or increase their availability—all of which might have an impact on sediment phthalates.
- Matters of disproportion to consider:
  - From now into the future, sediment phthalate sources and concern will increase due to population and product growth, which relate to the effort and resources available to identify and control phthalate sources.
  - Changes to affect sediment phthalate concentrations would likely need to occur at societal scale and we expect they would have significant economic impact.
  - More often human health (i.e., lead in gasoline) or clear obvious animal impacts (i.e., DDT effects on bald eagles) drive change at the levels needed to affect sediment phthalate concentrations.

Secondary Source Control and Treatment—Removal from Air

- Particulate removal, in general, can be used as surrogate for phthalates removal—air filters, low impact development, water treatment, etc.
- Filters to remove particulates would likely have an effect on phthalate removal (provided they do not contain phthalates themselves).

- Indoor air filters could be applied for other reasons.
- Air filters would unlikely affect outdoor air particulates and the sediment pathway.

Secondary Source Control and Treatment—Street Cleaning

- Effectiveness is dependent, in part, on the type of sweepers used; however, high-efficiency sweepers are expensive and don't work on all types of street surfaces and there are some concerns regarding effectiveness on wet streets. ***Please note—The Work Group notes that these conclusions on street cleaning were based on only a few studies and some contradictory information.***
- High-efficiency street sweepers still leave measurable percentage of small particles and phthalates that still enter drains.
- Street sweeping shows very low efficiency in removing silt and smaller sized particles, which have higher concentrations of phthalates.
- Street sweeping only affects a small percentage of an impervious watershed because the percent of total impervious surface area is limited. Limits include parking and other activities in the right-of-way, and the fact that most impervious surface (roofs, parking lots and driveways) are outside of the public right-of-way.
- Street sweeping would not likely have significant percentage removal effect on the total amount of phthalates reaching sediments; however, it is important to recognize that sweeping has additional benefits beyond phthalate removal.
- Information from Seattle sweeping pilot will be helpful.
- Sweeping may be an important element of a multi-component source control solution.
- Catch basin cleaning may also play an important role in the big picture.
- The percentage removal from catch basin cleaning versus street sweeping needs to be evaluated as data becomes available.

Secondary Source Control and Treatment—Stormwater Treatment

- Any treatment alternative that is effective for particle removal will have beneficial effect on phthalates loading.
- Most removal methods are limited effectiveness at small particle sizes—phthalates most associated with smaller particles.
- Small-scale treatments (smaller drainage areas) tend to be more effective and efficient than large scale treatments.
- Breaking large basins to smaller watersheds is useful to implement stormwater treatment, but can drive up total costs for construction and operation/maintenance. Expensive to implement many small scale systems over entire watershed—particularly in already-developed areas.
- It is difficult (if not impossible) to remove contaminants at low concentration levels (ppb) with traditional stormwater treatment methods designed to be effective at larger scales (drainage basins).

- We do not know what percentage TSS in sediment phthalate loading needs to be removed in order to prevent problems in sediments. It would be good to know what percent removal of a given particle size range would effectively control phthalates in sediments; however, this formula would be different for all locations because it is directly relates to the characteristics of the watershed and receiving environment.
- Traditional stormwater source control focuses on finding and controlling problem point sources early in their path to sediments and before the treatment happens at the basin level. The huge role of air deposition in the phthalates path to sediments is a problem because it is not a point source that can be controlled with existing technologies or regulations.
- Traditional stormwater treatment does not scale up well—requires very large storage area and land commitment.
- There are passive versus non-passive treatment alternatives—each type of treatment has implementation constraints.
- Chemical or biological waste water treatment facilities are not feasible for stormwater from large watersheds because natural flows are not steady and thus efficient to engineer treatment for. In turn, this means a lot great deal of storage (land area) is needed to provide steadier flows that could be efficiently treated. Current options are impractical.
- Chemical oxidation treatment:
  - ∗ In queue for pilot study for treatment plant application.
  - ∗ Concern re: potential application as a distribution system through the watershed—potential for unintended consequences.
  - ∗ Concern regarding regulatory prohibition against introduction of chemicals into environment—cannot use environment as treatment system.
- Treatment would not necessarily eliminate phthalate recontamination and a requirement for sediment cleanup. Loading of particulates exceeding CSL is hard to prevent because of the small size particles.
- Would need to analyze watershed, receiving environment and treatment characteristics to determine possible effect on recontamination potential.
  - ∗ Applicable treatment alternatives likely would not prevent sediment recontamination.
  - ∗ Potentially they would defer, but not eliminate, the need for sediment cleanup.
  - ∗ Could perform cost-benefit analysis of treatment versus cleanup if CSL enforced.
- For large urban watersheds with fairly quiescent receiving environments, unlikely that conventional stormwater treatment would prevent recontamination relative to CSL, but might delay need for additional cleanup.
- Could consider management of recontamination through thin layer capping in lieu of prevention – but the capping option brings issues too: instead of a chemical effect on the benthic infauna you have a physical effect from capping; and filling in of the waterway.

- Could compare treatment cost and size requirements to cost of cleanup, using 50-year time frame and different levels/types of treatment versus timing of cleanup.
- Evaluations of that sort would need to be presented so that reader could understand public expenditures for all alternatives and links to big picture that the funds are being expended for benthic protection.
- For treatment alternatives, could evaluate/compare the costs per acre of watershed, cost per amount of TSS removed.
- Acknowledge that treatment would need to meet several other objectives—other than only removing phthalates.
- Could design a receiving environment to treat the discharge (e.g., wetland treatment); however, having the receiving environment provide functions of treatment facility raises regulatory concerns.

Likely Practical Source Control and Treatment Alternatives

Brainstorm of likely practical alternatives given research on bans and treatment:

- Disconnect portions of watershed from outfall.
- Increase permeability of watershed to reduce discharge.
  - City of Tacoma study at the landfill regarding low-impact drainage alternatives will be helpful. Results are about 1 year away.
  - Other sources of data regarding low impact development would be beneficial.
- Implement periodic sediment cleanup like thin layer capping.
- Increased catch basin O&M and potential street sweeping.
  - Consider pilot regarding aggressive catch basin cleaning or targeting most efficient balance of cleaning and sweeping.
- Implement other alternatives to reduce particulates.
- Enhance dispersion of receiving environment to reduce deposition.
- Discharge to different receiving environment.
- Acknowledge Sediment Impact Zone (SIZ; recognize regulations currently establish SIZ as "temporary measure").

Consider potential pilot projects to improve understanding of the problems:

- Effect of aggressive maintenance sweeping and catch basin cleaning—must be done in conjunction with in-line sediment traps (before and after implementation) to measure effectiveness.
- Air monitoring to really document pathway (Puget Sound Clean Air Agency data?).
- Work to document particulate size related to air pathway.
- Particle size in stormwater and relation to phthalates—relation to maintenance.
- Particle size versus deposition in sediments.

- Focus on particular particle size of concern for phthalate air to sediment pathway and what treatment or maintenance actions would be effective.
- Reduction of key particle size in air emissions is a potential source control action.
- Bench tests?
- Recognize transformation in transport through media – air – stormwater.
- More clinical look at chemistry and emissions.
- Could this piggyback on other human health concerns for airborne particles of similar sizes?
- Low impact development—need for data regarding TSS removal.

PARKING LOT

Add to the “parking lot” regarding action items and alternatives development:

- DRCC, USEPA Innovation office could work to lobby for product substitution, etc., if we developed good message.
- Develop another illustration regarding types of plastic using phthalates.
- Consider role of tax on cars.
- Consider single-family homes regulation.
- Phthalates in indoor/outdoor air are not targeted by air quality agencies because the air exposure pathway is not a driver for human health.
- DEHP does not exceed Puget Sound Clean Air Agency’s screening levels as air toxic compound.
- Phthalate levels in our urban waterway sediments are not a concern for human health (other than tribal child subsistence) or macrofauna as far as we can tell. We have only documented benthic effects.
- The primary path of phthalates-to-sediments is from solids to air particulates followed by air deposition to impervious surfaces and stormwater. Note, however, that phthalates in air are not a concern for human health and are not regulated.
- Reduction of sediment phthalates will not apparently be driven by human health concern.

Sediment Phthalates Work Group
Technical Committee Meeting
Regulations
April 12, 2007

ATTENDEES

John O'Loughlin	City of Tacoma	joloughl@cityoftacoma.org
Kris Flint	EPA	flint.kris@epa.gov
Kathryn DeJesus	WA Dept. of Ecology	Kbco461@ecy.wa.gov
Jeff Stern	King County	Jeff.stern@metrokc.gov
Bruce Tiffany	King County	Bruce.tiffany@metrokc.gov
Pete Rude	City of Seattle	Pete.rude@seattle.gov
Seth Preston	WA Dept. of Ecology	spre461@ecy.wa.gov
Kate Snider	Floyd|Snider (facilitation)	kate.snider@floydsnider.com
Erin Murray	Floyd|Snider	erin.murray@floydsnider.com

This meeting summary was prepared by Erin Murray and Kate Snider. It is based on a transcription of the flip charts used during the meeting to document the discussion. Action items are identified in ***bold script***.

PURPOSE OF THE MEETING

The purpose of this meeting was to reach agreement on and document the key messages that are apparent from the material collected and reviewed regarding regulatory setting, to discuss the process for developing recommendation alternatives for Policy consideration, and to develop a comprehensive problem statement given the research completed to date.

REGULATORY SETTING

Regulations governing each of the media involved in the pathway of phthalates to sediments were discussed. Key messages were summarized, and include the following:

- The sediments phthalates contaminant pathway involves multiple media, including air, water, soil and sediment.
- Media-specific laws and regulations apply to each separately.
- Phthalates in different media have different risks and receptors
- Regulations for each media use different endpoints to evaluate risk in that particular medium.

- Most environmental laws and regulations establish goals for the protection of the environment and human health, but are not integrated into a coordinated regulatory system.
- Phthalates are not a site-specific problem, but are a non-point source concern.
- Product regulations are also pertinent.

Air

- Phthalates in air at concentrations needed to generate levels of concern in sediment do not trigger action regarding public health risk (levels not of concern for public health exposure).
- There is a narrative in the law regarding public health/welfare or environmental protection that could potentially be exercised in this segment of the contaminant pathway, but would need compelling rationale (e.g., CO_2 can be regulated under the Clean Air Act for environment health reasons; acid rain regulated under same reasoning)
- State Act is more clear and broader in rationale—plant/animal/environmental protection and economic effects.
- Regulatory authorities need to recognize the contribution of air to water pollution.
- Regulatory authorities need to understand the air to water pathway better to consider the idea of regulating air levels to protect water quality.

Soil and Groundwater

- CERCLA and the Model Toxics Control Act (MTCA) both recognize phthalates and can regulate their cleanup at contaminated sites.
- These regulations are reactive, or used to address contamination after it has occurred rather than prevent it and relevant to cleanup sites. They are not designed to control non-point sources, ubiquitous contaminants.
- Soil and groundwater regulations are not adequate to control contamination to the sediment pathway because they apply only to relatively small areas within the watershed. Phthalates are not a site-specific concern; they exist within the watershed as a whole.
- Phthalates in soil and groundwater at cleanup sites are not a significant source to the sediment pathway – air and surface water runoff are of much more significant concern.
- CERCLA and MTCA elements that require source control are relevant, and can be used to require source control actions for sediment sites. The requirement for permanent remedies will require source control components to adequately address phthalates.
- The issue of using joint and several liability requirements of CERCLA and MTCA to potentially engage product manufacturers should be investigated.

Water

- Water has the same issue as air in that water itself is not the problem. It is the transport mechanism (pathway) of phthalates to sediments.
- Phthalates do not pose a risk of concern currently recognized in water quality (i.e., not of concern for toxicity in organisms).
- Phthalate concentrations in surface water do not exceed numerical water quality criteria thresholds. Therefore, water quality criteria are not effective to protect sediment quality.
- Narrative standards regarding protection of aquatic life could be exercised in this segment of the contaminant pathway.
- However, State Clean Water Act and Water Quality Standards both require compliance with the Sediment Management Standards (SMS).
- SMS violations trigger 303d listings and potential source control actions (loading limits).

Clean Air and Clean Water Acts

- By current numerical standards, phthalates in air and water are not at levels that trigger concern.
- Narrative requirements — protection of the environment and aquatic species could potentially be used to control phthalates to sediments.
- The Clean Water Act (CWA) requires SMS compliance and has numerical and benthic effects criteria.
- Permit writers/regulators recognize links to sediment quality (and sometimes require sediment sampling) but current regulations don't provide mechanism to prevent eventual contamination to sediments via NPDES permits.
- We recognize that the CWA sets a goal that is unreachable in many situations with the current technology (not feasible to be reached — e.g., copper, etc., as well as phthalates). This must have been recognized when written. Relies on enforcement discretion.
- There are disconnects between regulations for different media (e.g., levels that are acceptable in air and water still can cause sediment effects because they accumulate and concentrate in the sediments). So sediment source control may require reliance on Clean Air Act provisions imposed on third parties.

Sediment

- Both MTCA and State CWA require compliance with SMS.
- The goal of the SMS regulation is to "reduce and ultimately eliminate adverse effects on biological resources and significant health threats to humans from surface sediment contamination."

- Phthalate contamination in sediments poses a greater concern to benthic organisms than to human health.

RECOMMENDATIONS—ALTERNATIVES FOR CONSIDERATION

Categories of Recommendations

When the technical committee develops recommendation alternatives for consideration by the Policy group, the following categories of recommendations will be addressed:

1. Studies/research (includes pilot studies) to fill data gaps and confirm key assumptions.
2. Near-term (5 year) coping mechanisms
3. Practical pathway control and regulatory measures — 5 to 20 year timeframe.
4. Grand-scale, long-term solutions

COMPREHENSIVE PROBLEM STATEMENT

Certain phthalates have accumulated in sediments at the end of urban stormwater outfalls. These phthalates, primarily DEHP and BBP, are plasticizers used in PVC throughout urban commercial and residential neighborhoods in numerous materials (e.g., vinyl flooring, shower curtains, etc.) and are very important to our economy.

Phthalates get to sediments because they off-gas into the atmosphere from phthalate containing materials. These products will continue to off-gas until they are brittle and most of the phthalate has been released. The vapor phase phthalates stick to fine particulates in the air and are then deposited throughout the watershed. If deposited on impervious surfaces, they are washed off in storm events from pavements, roofs, cars, and buildings into storm drains. Larger watersheds with more impervious surfaces contribute a larger mass of phthalates than smaller watersheds with less impervious surfaces. The phthalates can accumulate in the sediments where the storm drains empty into the receiving waters, particularly where the receiving water body is generally still and slow moving water.

When these phthalates are in the air and water (before reaching the sediments), they are not at concentrations that trigger regulatory concern due to human or environmental health. When they get to the sediments they don't migrate much. They can accumulate within a few years to levels that adversely affect the benthic organisms (such as worms, sand fleas, clams, etc.) at the bottom of the food chain that live in the sediments. Phthalates do not readily bioaccumulate, therefore, there is minimal risk to larger animals and human health (except for a very small population of subsistence seafood consumers—where the risk is still very low and much less than that of many other chemicals). Even so, Ecology sets numeric criteria under SMS (under the state Clean Water Act) to protect against effects to benthic organisms, because these effects are indicative of a change to the ecosystem.

It is important to note that this project is focusing on phthalates in sediments. Phthalates in cosmetics, medical apparatus, toys, etc. pose different health risks and are frequently different types of phthalates as well. Those phthalates and risks associated with them are not related to phthalates in sediments and are outside this project's scope.

After sediment cleanups (typically for multiple chemicals) in quiescent aquatic environments with tributary urban watersheds, phthalates are reaccumulating within a few years to levels that exceed the SMS criteria.

Due to the way that phthalates get to sediments, they are virtually impossible to control. We can't stop them from off-gassing and being deposited on impervious surfaces because there are billions of pounds of plasticized PVC products currently out in the environment that will continue to off-gas until the products are brittle and no longer contain phthalates — this takes many years. A potential ban on use of phthalates in plasticized PVC products would be very difficult to implement, and would not have a significant effect within the next 20 to 30 years, due to the enormous existing reservoir of phthalates already out in the environment and the predominance of phthalate-containing imported products (which are difficult to control).

Phthalate loading to storm drains could potentially be reduced through effective removal of fine particulates or by increasing permeable surfaces within a watershed. However, given the scale of urban watersheds and airsheds, measures to remove phthalates would likely not be effective in preventing reaccumulation in sediments. These measures might lengthen the timeframe of reaccumulation but would not eliminate the problem.

There may be other ways to address the issue of phthalates in sediments; however it is a very complex problem. Proposed alternatives need to address the near-term dilemma, practical pathway and regulatory controls, and potential long-term change.

GRAPHICS TO ASSIST IN COMMUNICATING ALTERNATIVES AND ISSUES

- Pathway diagram of phthalates to sediments. Use figure different ways: pathways, exposures, regulations.
- Relative risk phthalate exposure from different sources (putting sediment risks in perspective)
- Relative risk of phthalate exposure relative to other chemicals?
- Illustrate products that contain plasticized PVC
- Regulatory flow chart (maybe illustrate on pathway diagram)?

Sediment Phthalates Work Group
Technical Committee Meeting

September 11, 2007

ATTENDEES

John O'Loughlin	City of Tacoma	joloughl@cityoftacoma.org
Kathryn DeJesus	WA Dept. of Ecology	Kbco461@ecy.wa.gov
Kris Flint	EPA	Flint.Kris@epamail.epa.gov
Jeff Stern	King County	Jeff.stern@metrokc.gov
Bruce Tiffany	King County	Bruce.tiffany@metrokc.gov
Pete Rude	City of Seattle	Pete.rude@seattle.gov
Seth Preston	WA Dept. of Ecology	spre461@ecy.wa.gov
Kate Snider	Floyd|Snider (facilitation)	kate.snider@floydsnider.com
Erin Murray	Floyd|Snider	erin.murray@floydsnider.com

This meeting summary was prepared by Erin Murray and Kate Snider. It is based on a transcription of the flip charts used during the meeting to document the discussion.

PURPOSE OF THE MEETING

This meeting was the final meeting of the Sediment Phthalates Work Group. The purpose of this meeting was to: 1) reach agreement on and finalize the Work Group's Final Product; 2) discuss OMMP considerations with respect to re-accumulation of phthalates at sediment cleanup sites; and 3) to produce a summary of the recommended studies organized by pathway.

FINAL PRODUCT CONTENTS

The Work Group final product will include:

- Work group description and overview, including a new paragraph describing rationale for including the paper with more detail on the air to sediment pathway
- Comprehensive problem statement
- Phthalate occurrence figure
- Recommendations

Attachments

- Work Group Member List (alphabetize)
- Meeting Notes
- Source Material Bibliography

- Further Detail re: Air-Stormwater-Sediment Pathway paper

OMMP CONSIDERATIONS REGARDING PHTHALATE REACCUMULATION

One of the key work group recommendations is presented as recommendation #3 in the Work Group Final Product:

Manage Phthalate Reaccumulation at Cleanup Sites Using Site-specific O&M Plans

Develop considerations related to phthalate reaccumulation to be taken into account in development of site-specific O&M plans for CERCLA and MTCA sediment cleanup sites. This can likely be performed by the Technical Committee of the Work Group, and would serve as a starting point for consistent criteria to be considered on a site-specific basis.

- *Considerations could include developing appropriate triggers for action (i.e., localized size of impacted area and level of exceedances, co-occurrence with other target pollutants, beneficial use-specific targets) and options for ongoing O&M and triggered actions (i.e., continued monitoring, thin layer capping or removal, outfall engineering).*

Consider relationship to National Pollutant Discharge Elimination System (NPDES) requirements that are tied to SMS.

The material that follows provides more detail to this recommendation. The technical committee discussions raised several thoughts and issues that we recommend as things to be considered during the development of Operations Monitoring and Maintenance Plans (OMMP) for specific sediment cleanup sites.

1. A key baseline assumption in the development of an OMMP for a sediment cleanup site is that the remedy will include an aggressive, on-going source control program to identify and control point sources and contributions of contamination. (The work group notes that the aggressiveness of a given source control program will, of course, depend on the resources available for carrying out the work of identifying, characterizing and controlling known/suspected sources across drainages that are often much larger than the actual sediment cleanup area.)
2. Additionally, it is assumed that the cleanup remedy or OMMP action triggers could consider potential engineering controls that could assist in minimizing sediment deposition off primary stormwater outfalls.
3. Acknowledge that non-point atmospheric deposition sources will contribute to sediment reaccumulation of phthalates, and that the amount of phthalates will be greater in larger urban watersheds containing significant percentages of paved area.
4. In development of a monitoring approach, consider methods to distinguish the loading from point source inputs and non-point source inputs (e.g., atmospheric deposition).
5. Consider development of a monitoring approach that will assist in identifying and locating point source inputs:
    - Consider the variability in the watershed to provide adequate geographical coverage to detect point sources.

- Consider attempting to quantify likely maximum atmospheric deposition given watershed conditions to compare to monitoring data.
- Consider a program design with statistical evaluation of the data in both the drainage basin and the sediment, to evaluate for trends, and to compare against historical data and data from other parts of the drainage.

6. Consider modeling and/or initial phases of monitoring to predict the likely discharge loading, as well as, future extent and concentrations of phthalate accumulation related to non-point atmospheric deposition sources
    - In the absence of site specific data (in-line sediment, whole water or atmospheric deposition data), an approximate deposition of 2 ug/m^2/day on to the watershed could be considered as a starting point for highly urbanized drainage basins or 1 ug/m^2/day for less urbanized areas. The surface area drainage for the discharge may be considered as a potential source of X Kg/year to the sediment, calculated from the site specific data or from the drainage area and the deposition rate.
    - The size and average concentration of the impacted area will be a site specific consideration based upon factors such as: size of the drainage, land use, the rainfall patterns for the year, circulation patterns in the receiving water (including quiescence), sediment movement in the affected area (deposition & re-suspension), the mass of phthalate from the non-point atmospheric source (determined from site specific data such as: atmospheric deposition, in line sediment samples and whole water samples), and phthalate degradation rates along the pathway.
7. Consider the anticipated duration for accumulation to exceed standards in the area of concern when defining appropriate contingency actions.
8. Consider anticipating such accumulation during development of the OMMP in order to discuss appropriate actions and triggers for actions that acknowledge the expected re-accumulation.
9. Consider triggers that include both the extent of the area of reaccumulation and the concentrations within that area.
10. Consider the physical, biological and land use characteristics of the outfall area when defining appropriate triggers and contingency actions
11. Consider the effect that the presence of other contaminants would have on the definition of triggers and contingency actions.
12. Consider the anticipated reaccumulation in the context of other ecological priorities and beneficial uses related to the area.

SUMMARY OF RECOMMENDED STUDIES

A summary of recommended studies, organized by the element of the air-stormwater-sediment pathway addressed, was prepared and is attached. The Technical Committee's opinion is that further literature review is needed to determine sufficiency of data on other pollutants that may follow a diffuse atmospheric depositional source pathway prior to considering the need for specific studies.

Sediment Phthalate Work Group Issue	Study(s) to confirm
There may be many pollutants that follow a diffuse atmospheric depositional source pathway. This class of pollutants could be called other "pervasive population pollutants" or P^3s.	Develop methods to analyze whole air, whole water, particulates in air, particulates in water and the particle size distributions for a wide class of potential P^3s. (**Note 1:** For air sampling, high-volume air sampling methods exist for PAH, PCBs and selected metals through EPA's compendium of air toxics methods. High volume air sampling methods need to be developed and promulgated for other P^3s (e.g., phthalates, PBDEs, etc.) - **Note 2:** For water sampling, trace-level sampling and analytical methods need to be either developed or improved. For phthalates, and DEHP in particular, blank-related artifacts can be introduced into results from the sampling apparatus and laboratory air. As analytical detection limits get lower and lower, the impact from P^3s in urban particulate can have a significant impact on analytical results. The development of ultra-trace analytical chemistry laboratories and associate field sampling techniques may be needed.)
We need a multimedia and multiphase model for the fate and transport of P^3s.	Develop methods to analyze whole air, whole water, particulates in air, particulates in water and the particle size distributions for a wide class of potential P^3s.
	Determine the source of air particulates in areas of concern.
	Evaluate the dynamics of air movement within and outside the drainage basin of concern.
	Evaluate percentage of identified P^3 contamination in the sediments that is coming via the air pathway. Acknowledge other sources (marinas, etc.) and study those other sources. Consider source sampling at marinas and update of sediment trap source ID work.
	Study the breakdown of phthalates (and other identified P^3s). How do they breakdown? Determine how quickly they degrade in various receiving environments—specifically, air, water, marine sediments, freshwater sediments, and soils.
Source control and treatment options currently represent uncertain efficacy.	Study BMP (catch basin cleaning, street sweeping) efficiency
	Systematic evaluation of stormwater treatment alternatives with selected pilots. Implement those treatment methods that may prove effective and feasible.
	Do a cost/benefit analysis on source control and treatment options for identified P^3s versus repeated cleanup in area of impact.
	Investigate air particulate controls and mechanisms to reduce identified P^3s on particulates in the air (reduction in particulates may reduce off-gassing and the mass of P^3s that reach the ground).
	Evaluate fate and risk of identified P^3s in soil if watershed is disconnected and permeability is increased.
	Study bioremediation or other in-situ remedies for identified P^3s in sediments.
Phthalates in sediments do not bio-magnify up the food chain.	Look at fish tissue concentration of identified P^3s and correlation with other compounds. Where are fish picking it up? Fish tissue concentrations of phthalates are somewhat transient and metabolize out – study this better and determine controlling mechanisms for identified P^3s.
There may be other ways to remove phthalates from sediments.	Consider more studies on product/plasticizer alternatives and coatings (and product substitutions for other P^3s) and their potential concerns, benefits, and costs.
	Look at places where there have been bans on phthalates. Is there any useful data?

Appendix C

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Occurrence

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Appendix D

Overview of Technical Research on the Air–Stormwater–Sediment Pathway

Sediment Phthalates Work Group

Overview of Technical Research on the Air–Stormwater–Sediment Pathway

Prepared by
City of Tacoma
City of Seattle
King County
Washington State Department of Ecology
U.S. Environmental Protection Agency

with assistance from
FLOYD | SNIDER

September 2007

Introduction

This paper details the findings of the Sediment Phthalate Work Group (Work Group) with respect to fate and transport of phthalates in the environment to the sediment end point. The goal of this paper is to provide a link between the comprehensive problem statement in the summary documents and the binder of research papers that the summary is based upon.

Two hundred to three hundred million pounds of di-(2-ethylhexyl) phthalate (DEHP) is produced each year in the United States alone. Ninety to ninety-five percent of that DEHP is used to add flexibility to (i.e., “to plasticize”) PVC products. The plasticized PVC is used in construction, automobile upholstery, wire/cable coatings, consumer products, and coated fabrics. Potentially hundreds of millions more pounds of DEHP are imported annually when these types of products come from overseas manufacturers.

In the manufacturing process, phthalates are simply mixed into the PVC and are not chemically bound to the polymerized vinyl chloride chain. Therefore, they off-gas from finished products made with plasticized PVC. The vapor phase phthalate has a strong affinity to stick to particles in the air. Once attached to the particles, the predominant phthalate fate and transport mechanism is governed by particulate transfer between various environmental media (e.g., air to surface water to sediment). Given that this is a surface interaction, the majority of the phthalates will attach to the majority of the available particulate surface area (i.e., small particles).

Ultimately, the particles that settle onto impervious surfaces that drain to, or fall directly into, the waterway can accumulate in sediments.

Information Sources and Caveats

It is important to consider the purpose and any potential bias by the authors when a source of information is evaluated.

- Peer reviewed journals are given considerable weight.
- Government environmental health "white papers" are considered reliable, though they are often written by a committee so some minor conflicts may occur between sections.
- Industry production numbers are generally considered reliable on a broad scale given their use by industry analysts to make large dollar investment decisions.
- Mainstream news media pieces are generally considered unbiased, but often lack scientific expertise to give a complete description.
- Persuasion/Advocacy pieces are used to identify potentially useful studies, though the conclusions should be independently corroborated.

This paper may differ from some of the papers it quotes in some aspects:

- Most papers were written to address a different issue (i.e., the potential for human health effects) and addressed production, use, fate and transport as a peripheral issue.
- Papers haven't been misrepresented, but all conclusions from all papers are not incorporated. Sometimes authors missed key facts.
- This presentation is intended to synthesize all of the information reviewed (not to present each individual paper in its own light).

Publications by Key Governmental Environmental Health Organizations

Publications written by key environmental health and governmental organizations ("white papers") were the primary reference source for the Work Group's research on fate and transport. Most of these publications have been the subject of multiple studies and undergo extensive scrutiny by "blue ribbon" panels.

These are papers written for various reasons, but they all contain an environmental fate and transport section and specifically call out the mechanism described herein as the major environmental pathway. The list of authors on these publications tends to be extensive and consist of many PhD experts.

The publications primarily consulted for the Work Group's research on phthalates were the:

- World Health Organization (WHO; 1992)
- Agency for Toxic Substances and Disease Registry (ATSDR; 2002)
- European Commission Report (2002)
- California Environmental Protection Agency (EPA; 2006)
- National Environmental Research Institute (NERI; 2001)

Production of DEHP

DEHP, also known as bis(2-ethylhexyl) phthalate (BEHP) and dioctyl phthalate (DOP), is produced from phthalic anhydride (PAN) and 2-Ethylhexyl alcohol. The literature says about 50 percent of the PAN produced in the U.S. is used to make phthalates. Literature also says that approximately 50 percent of the mass of phthalate produced is DEHP. Finally, more than 90 percent of DEHP is used to plasticize PVC.

The following table shows consensus values gleaned from the trade journals in millions of pounds of chemical per year.

Consensus Literature Values (millions of lbs per year)				Consensus Literature Values (millions of lbs per year)			
Year	**PAN**	**DEHP**	**PVC**	**Year**	**PAN**	**DEHP**	**PVC**
1985	820	275	6,772	1995	994		12,295
1986	863	291	7,256	1996			13,220
1987	1,035	343	7,971	1997	1,002		14,084
1988	999	344	8,350	1998	1,032		14,502
1989	917	306	8,478	1999	1,076		14,912
1990	939	310	9,096	2000	994		14,442
1991	884	270	9,164	2001	1,057		14,257
1992	897	270	9,989	2002			15,297
1993	853	254	10,257	2003			14,702
1994	959	259	11,712	2004			15,985
				2005			15,258

When reviewing notes on production numbers it is important to keep some basic concepts in mind. Production is the actual amount made, which may include material exported as well as used within the producing nation; capacity is the amount that the industry could make if it were 100 percent utilized; and demand is the amount that customers actually buy from the producers (which, could include imports from other nations). Depending on the source in the business literature, the numbers you see reported could be any one of these. Additionally, as the controversy arose around DEHP in the 1990s, public reporting of production data declined. This is the main reason that there are empty boxes in the table above.

Europe is restricting use of DEHP so production there is declining. Some U.S. companies doing business in the European Union want to have consistent processes so production may decline here as well, but to a lesser extent. With the rapid growth of Asian markets, DEHP production and use is increasing in several of these countries.

PUBLICATIONS BY KEY GOVERNMENTAL ENVIRONMENTAL HEALTH ORGANIZATIONS

World Health Organization (WHO) 1992

> *"Globally, about 2.7 x 10^6 metric tonnes (5.9 billion pounds) of total phthalates are produced annually, DEHP accounts for well over 50% of the tonnage."*

Agency for Toxic Substances and Disease Registry (ATSDR) 2002

> *"1998 U.S. domestic production of DOP (aka DEHP) was 285 million pounds. Previous years showed domestic production volumes of 309 - 258."*

European Commission Report 2002

> *"It is clear from a variety of sources that it is DEHP which is most commonly used, constituting approximately 50% of the market for PVC plasticizers in Western Europe."*

Uses of DEHP

Phthalate esters are a major class of plasticizer. Greater than 90 percent of DEHP produced worldwide is used to plasticize PVC to make it flexible. DEHP is not covalently bound to the vinyl chloride polymer, so it acts as a molecular lubricant that allows the chains of PVC to move, which makes the PVC product more flexible. Pure PVC is hard and rigid and this form is used to make PVC pipe. The amount of phthalate present in plasticized to unplasticized PVC is a continuum — the concentration of DEHP can range from fairly negligible in rigid, unplasticized PVC up to mid-percent levels in many forms of plasticized PVC.

Examples of plasticized PVC include: wire and cable coatings; packaging materials; plastics wraps; fabrics; roofing materials; furniture and upholstery; wall coverings; house wares; children's toys; medical devices; medical storage and delivery products; and automotive parts and accessories. Plasticized (flexible) PVC materials may contain from 10 to 40 percent DEHP by weight.

This is not an argument to stop or continue use of PVC. This paper only looked at PVC to evaluate the use and distribution of phthalates.

PUBLICATIONS BY KEY GOVERNMENTAL ENVIRONMENTAL HEALTH ORGANIZATIONS

World Health Organization (WHO) 1992

> *"Phthalate acid esters are the most widely used plasticizers for the production of polyvinyl chloride (PVC) products (with DEHP as the most common plasticizer)."*
>
> *"Phthalate plasticized PVC is used for the insulation of wires and cables, in floor tiles, weather stripping, upholstery, garden hose, swimming pool liners, footwear, clothing, food wraps and containers."*

Agency for Toxic Substances and Disease Registry (ATSDR) 2002

> *"DEHP's predominant use is as plasticizers in flexible products made from polyvinyl chloride."*
>
> *"At least 95% of DEHP produced is used as a plasticizer for PVC, which may contain up to 40% DEHP."*
>
> *"DEHP is present in plastic products such as wall coverings, tablecloths, floor tiles, furniture upholstery, shower curtains, garden hoses, swimming pool liners, rainwear, baby pants, dolls, some toys, shoes, automobile upholstery and tops, packaging film and sheets, sheathing for wire and cable, medical tubing, and blood storage bags."*
>
> *"Numerous nonplasticizer uses of DEHP have been reported; however, it is not clear to what extent these uses are, or have ever been, important."*

"TRI (Toxics Release Inventory) data should be used with caution since only certain types of facilities are required to report."

European Commission Report 2002

"It is clear from a variety of sources that it is DEHP which is most commonly used, constituting approximately 50% of the market for PVC plasticizers in Western Europe."

California Environmental Protection Agency (EPA) 2006

"Flexible PVC examples include wire and cable coatings, packaging materials, plastics wraps, fabrics, containers, bottles, roofing materials, furniture and upholstery, wall coverings, house wares, exterior siding, children's toys, medical devices, medical storage and delivery products, automotive parts and accessories. Rigid PVC products examples are pipes and vinyl window casings."

"Large releases are rare during manufacturing."

This is not to say that industry is never a point source. Certainly, industrial releases do happen. However, the Work Group did not find that industrial releases were a common occurrence, nor did they account for a substantial portion of the phthalate budget in the environment. This is supported by the ubiquitous occurrence data.

"Useful lives of PVC products may be short (days - packaging and films); intermediate (10 years - flooring, carpet, or roofing materials); or long (50 years - pipes, window casings, appliances)."

"The phthalate plasticizer most widely used is DEHP."

BUSINESS LITERATURE JOURNALS

The following are examples of the business literature reviewed to confirm the production and uses of phthalates.

"…make them soft and stretchable. Products made from rigid PVC (75% of total demand are chiefly extruded (94%) or molded (6%) items: pipe and conduit, fittings, automobile parts, blow molded products and roofing tiles. Flexible PVC (25% of total demand) finds outlets in calendared sheet, wire and cable coating, flooring, coated fabrics, shower curtains, automobile upholstery and furniture."

ICIS Chemical Business Americas; Sep 11-Sep 17, 2006; 270, 9; ABI/INFORM Global pg. 37

> *"Is the cable exactly the same today as when it as installed? Probably not. In its pure form, polyvinyl chloride is rigid and brittle. Cable manufacturers add plasticizers to make the PVC flexible. Phthalates, which look like vegetable oil, area most often used in flexible PVC. Because the phthalates are not chemically bonded to the PVC, they tend to outgas over time, so to extend the life of the flexible PVC…"*

Cabling Installation and Maintenance; Oct 2005; 13, 10; ProQuest Telecommunications pg. 10

> *"With the advances in solvent printing technology and the growing demand for longer-lasting, outdoor-durable graphics, vinyl has gotten a new lease on life for outdoor graphics projects–providing shops with another "weapon" in their arsenal of products. Many of these graphics can be printed more efficiently on vinyl, offering better fade and tear resistance, and are a lot more cost-effective–both in material and labor."*

Wide–Format Imaging; Nov 2006; 14, 11; ABI/INFORM Trade & Industry pg. 11

> *"Most observers of green building (including this writer) anticipated that the five-member task group would come down hard on PVC—either that a LEED credit be given for excluding PVC from USGBC-certified projects, or perhaps going so far as to recommend banning vinyl from LEED-rated projects entirely…the available evidence does not support a conclusion that PVC is consistently worse than alternative materials on a life cycle environmental and health basis."*

Building Design & Construction; Feb 2005; 46, 2; ABI/INFORM Global pg. 5

> *"The Marketplace wars persist over health risks—real or perceived—from plastic packaging made from polyvinyl chloride (PVC) resins. But this much is true: Microsoft just stopped using PVC clamshell packs to protect new copies of its software products and several other manufacturers are following suit."*

Purchasing; Feb 16, 2006; 135, 2; ABI/INFORM Global pg. 44

> *"As an example, we consider a product-specific configuration that was put together from a proven standard modular system. The range is a two-stage coating line for production of, for example, polyvinyl chloride (PVC) tarpaulins or a starting material for sunshade lamella. Here, a process for production of PVC tarpaulins is described."*

Technical Textiles International: TTI; May 2005; 14, 3; ABI/INFORM Trade & Industry pg. 39

"Polyvinylchloride (PVC) material is manufactured using one of two techniques: lamination or extrusion. In both cases, the PVC is attached to a scrim of woven nylon or polyester. Scrim being an open weave fabric."

Wide–Format Imaging; Mar 2006; 14, 3; ABI/INFORM Trade & Industry pg. 18

"Phthalates are multipurpose plasticizers that find broad application. Because alternatives are more expensive than phthalates, they will not be broadly tested unless bans on phthalates are imposed on industry. As a result, phthalates remain the dominant class of plasticizers. They compose about 87 percent of the 10.4 billion-lb-per-year world market for plasticizers." (Tullo 2005).

THE 5 TO 10 PERCENT OF DEHP USED IN PRODUCTS OTHER THAN PVC

As has been stated above, it is not clear how significant any of these uses are now or ever have been to the fate and transport of DEHP in the environment given that they represent only 5 percent of the potential source mass. For completeness however, below is a list of the primary uses for phthalates beyond plasticizing PVC:

- PCB replacement (dielectric fluids for electric capacitors)
- Defoamer (paper manufacturing)
- Chemical intermediate (insect repellant)
- Cosmetics
- Detergents
- Lacquers
- Munitions
- Industrial lubricant

WHAT ABOUT SOURCES BESIDES PVC?

The group also looked at ways to characterize other sources of phthalate than PVC. The main resources and conclusions drawn from them are listed here.

- Profile of the Rubber and Plastics Industry by EPA.
- Census Bureau Data for various industries.
    - ∗ It looked fruitful but wasn't helpful
    - ∗ Reported in terms of dollars not pounds of chemical
    - ∗ Contained too many variations in reporting categories of industry and use

All of the other sources of phthalates together can only explain 5 to 10 percent of the estimated gross production. And most of these products are used in a diffuse manner as well. Product testing shows variable and relatively low (typically much less than 100,000 ppb) concentrations of DEHP compared to percent levels of plasticized PVC.

PRODUCT TESTING

Levels of phthalates in various products that have relatively direct access to stormwater have been tested by the City of Tacoma and others for many years. The following table presents a portion of the results (measured in ug/Kg – parts per billion).

Source	Bis(2-ethylhexyl) phthalate
Brake Pad NAPA TS-728A-M	170,000
Brake Pad NAPA TS-728A	33,000
MOPAR brake pad, used	1,100
Ford-Motorcraft brake pad, new	920
Used Car brake pad dust	52,000
Used Car brake pad- Auto	4,000
Tire Dunlop K327MG	12,000
Tire Sears Guardsman 4OT/E	47,000
Tire Goodyear Integrity	5,400
Ford-Motorcraft Serp Belt- used	900,000
MOPAR Serp Belt- used	21,000
Ford-Motorcraft Serp Belt-new	3,900
New Cigarette butt Marlboro light 100	5,400
Used Cigarette butt- Muni	67,000
Plastic Bottles -Tacoma Recycling	810
Packing Peanuts- Tacoma Recycling	18,000
Crafco Asphalt Sealer	16,000
US Oil Liquid Asphalt- NC800	19,000
US Oil Asphalt Cement	20,000

These concentrations typify the results from these product testing efforts: there is no one category of product that consistently has high levels of phthalates. In contrast though, plasticized PVC can contain 100,000,000 ppb (i.e., 10 percent) or more.

It is illustrative to compare the relative amounts of product necessary to account for 1 Kg of DEHP in the environment:

Brake linings: 170,000 ug/Kg DEHP (Highest value measured)

Vinyl flooring: 170,000,000 ug/Kg DEHP (Assumes 17% DEHP – Feasible Range: 10 to 40%)

Thus, to account for 1 Kg of DEHP in the environment:

6,000 Kg of brake linings, or

6 Kg of vinyl flooring

What this example shows is consistent with the "Uses of DEHP" section of this paper: the vast majority of DEHP is associated with plasticized PVC. The remaining 5 to 10 percent of DEHP use is not environmentally significant on any broad scale. However, the contributions from these other sources, although minor, can still add to the total mass loading of DEHP in urban drainage basins.

Fate and Transport of DEHP

The fate and transport of DEHP in the environment has been reported upon by many organizations. The consistent conclusion from these studies is that airborne transport of DEHP is the primary pathway by which it is distributed.

PUBLICATIONS BY KEY GOVERNMENTAL ENVIRONMENTAL HEALTH ORGANIZATIONS

World Health Organization (WHO) 1992

> *"Transport in the air is the major route by which phthalates enter the environment. From the atmosphere DEHP either falls or is washed out via rainfall."*

This statement alone constitutes a high level of confirmation of the air-stormwater-sediment pathway.

> *"DEHP is readily adsorbed by organic soil/sediment particles. It is adsorbed particularly by small particles, and adsorption is enhanced in salt water."*

> *"Atmospheric photodegradation of DEHP is rapid."*

This degradation pathway applies to the vapor phase DEHP, the degradation rate is much less for DEHP attached to particulates.

National Environmental Research Institute (NERI) 2001

> *"DEHP was the most abundant substance found."*

> *"Freshwater from streams were the predominant DEHP source to the fjord, followed by atmospheric deposition and wastewater treatment plants."*

This paper does not explicitly draw this conclusion, but the likely source to the freshwater streams is through a combination of direct atmospheric deposition to the water bodies and indirect atmospheric deposition within the associated drainage basins.

Agency for Toxic Substances and Disease Registry (ATSDR) 2002

> *"Industrial releases are only a fraction of the total environmental releases of DEHP. Release of DEHP into the environment is thought to originate from diffuse sources, mainly from end-uses of DEHP (e.g., as an additive to plastics)."*

> *"Authors could not correlate DEHP (air) fallout rates with specific sources or transport routes. They found no "distributional patterns or gradient", which possibly suggests that emission sources of roughly equal magnitude are diffuse."*

"The possibility of many diffuse sources of DEHP is potentially supported by some of the uses that have large surface area-to-volume ratios, which might allow DEHP to volatilize readily."

"Adsorption onto soils and sediments is a significant sink for DEHP. DEHP released to water adsorbs strongly to suspended particulates and sediments (Al-Omran and Preston 1987; Staples et al. 1997; Sullivan et al. 1982; Wolfe et al. 1980a)."

"Adsorption of DEHP to marine sediments might be greater than adsorption to freshwater sediments, due to reduced solubility of DEHP in saltwater."

"DEHP shows greater adsorption to the smaller size particle fractions of suspended particulates or colloids."

"Total end-use emissions of DEHP to the air from indoor household uses in Europe is approximately 300 tons per year [0.6 million pounds]. *Emissions from exterior end uses were estimated to be 2,600 tons (5.2 million lbs) per year for DEHP (this estimate was not well defined). These estimates support the conclusion that the major sources of DEHP are from end-uses and that these represent a geographically diffuse source."*

"Cadogan et al. (1994) and Cadogan and Howick (1996) reported that an indoor emission rate of $2.3x10_{-4}$ *mg/second-*m_2 *at 25°C* [approximately, 20,000 µg/m^2/day] *has been calculated for all phthalate plasticizers in products such as wall coverings, flooring, upholstery, and wire insulation."*

"DEHP is ubiquitous in air at low concentrations (e.g., 0.06–5.0 ng/m_3*) (Eisenreich et al. 1981; Ligocki et al. 1985a), is in both the vapor phase and associated with particulates, and is subject to both wet (rain and snow) and dry (wind and settling) deposition on the Earth's surfaces. Eisenreich et al. (1981) calculated that wet and dry deposition of DEHP into the five Great Lakes amounted to approximately 47.7 metric tons per year, which corresponds to an average fallout rate of 16.2 µg/*m_2 *per month* [approximately, 0.5 µg/m^2/day]*."*

Air deposition testing conducted in rural British Columbia had a DEHP air concentration of 3.6 ng/m^3 (Belzer 2004). If a typical air deposition velocity of 0.2 cm/second is used (Simcik 2004 and SFEI 2005), the resulting air deposition flux is approximately 0.6 µg/m^2/day, which has close agreement with the air deposition flux reported for the Great Lakes. This supports the idea that diffuse sources of phthalates contribute to depositional loading to drainage basins.

"Atmospheric fallout is negatively correlated with temperature so that less DEHP is subject to fallout in the summer than in the winter (Staples et al. 1997; Thurén and Larsson 1990). This is in keeping with a higher proportion of the atmospheric DEHP in the vapor state in the warm summer and less in the cold winter, and further indicates that the partitioning between particles and vapor are controlled by vapor pressure. DEHP is removed from the atmosphere by both wet (rain and

snow) and dry (wind and settling) deposition (Atlas and Giam 1981; Eisenreich et al. 1981; Ligocki et al. 1985a, 1985b)."

"Reaction of DEHP vapor with hydroxyl radicals in the atmosphere has been predicted, with an estimated half-life of about 6 hours using the Atmospheric Oxidation Program (Meylan and Howard 1993). The atmospheric half-life, however, is expected to be longer for DEHP adsorbed to atmospheric particulates. Based on the estimated half-life alone, extensive transport of DEHP would not be expected and concentrations in Antarctic snow would not be predicted. Nonetheless, DEHP appears to be present in urban and rural atmospheres (see Section 6.4), and its transport might be mainly in the sorbed state. Data confirming this degradation pathway have not been located. Direct photolysis and photooxidation are not likely to be important (Wams 1987)."

If DEHP existed primarily in the vapor state, it would be rapidly degraded and it would not be detected in remote areas, including the Arctic and Antarctic. However, because it is detected in these remote areas, equilibrium with the vapor phase does not appear to be significant, which supports particle transport as the governing process for evaluating fate and transport of DEHP.

"DEHP has been reported over the Pacific and Atlantic Oceans at mean levels of approximately $1.4x10^{-6}$ mg/m3 ($3.2x10^{-7}$–$2.6x10^{-6}$ mg/m3, 0.32–2.68 ng/m3) (Atlas and Giam 1981; Giam et al. 1980), in outdoor air in Sweden at a median concentration of $2.0x10^{-6}$ mg/m3 ($2.8x10^{-7}$–$77.0x10^{-6}$) mg/m3, 0.28–77.0 ng/m3) (Thurén and Larsson 1990), over Portland, Oregon at a mean level of $3.9x10^{-7}$ mg/m3 ($6.0x10^{-8}$–$9.4x10^{-7}$ mg/m3, 0.06–0.94 ng/m3) (Ligocki et al. 1985a), and over the Great Lakes at a mean concentration of $2.0x10^{-6}$ mg/m3 ($5.0x10^{-7}$–$5.0x10^{-6}$ mg/m3, 0.50–5.0 ng/m3)"(Eisenreich et al. 1981).

DEHP mean air concentrations for Pacific/Atlantic Oceans, Sweden, Portland, and the Great Lakes were 1.4, 2.0, 0.4, and 2.0 ng/m^3, respectively. If a typical air deposition velocity of 0.2 cm/second is used (Simcik 2004 and SFEI 2005), the resulting air deposition flux values for these locations are approximately 0.24, 0.35, 0.07, and 0.35 µg/m^2/day, respectively. These results indicate that there is a global distribution of DEHP in the atmosphere that returns to terrestrial surfaces in the form of atmospheric deposition.

"Indoor air levels in rooms with new flooring could be about 0.2–0.3 mg/m$_3$ (Wams 1987)."

"Increases in DEHP emissions with increasing ambient temperature are especially important within car interiors, where DEHP concentrations in air have been shown to range from 1 µg/m$_3$ at room temperature to 34 µg/m$_3$ at 65°C (Udhe et al. 2001)."

Off-gassing of DEHP is temperature dependent. Since DEHP is not chemically bonded to PVC, it is not surprising that more of it would volatilize (i.e., "off-gas") as temperature increases.

European Commission Report (2002)

> *"….without any covalent linkages to the polymers chains, the plasticizer must be considered mobile and capable of migration."*

Australian Environmental Protection Agency (EPA) Fact Sheet

> *"DEHP in the atmosphere is present either as a gas or attached to solid particles. The gas breaks down relatively quickly (1 or 2 days) due to the action of other chemicals in the atmosphere. The solid particles are estimated to be removed from the atmosphere in a period of two to three weeks by various mechanisms including precipitation, wash out by rain and reaction with other chemicals. It doesn't break down easily in deep soil, or in lake or river bottoms."*

> *"About 42.8% of DEHP will eventually end up in terrestrial soil; about 40% will end up in aquatic sediments; and about 17% will end up in air."*

Indoor Air Studies

The following studies evaluated the presence of phthalates in indoor air. For information on the concentrations of DEHP in indoor air, please see Table D.1. These studies also definitively establish off-gassing from plasticized PVC as a source for DEHP to the air.

BORNEHAG ET AL (2005)

For both butyl benzyl phthalate (BBzP) and DEHP, this study found associations between their dust concentrations and the amount of PVC used as flooring and wall material. This is not cause and effect, but it is an important correlation that corroborates the fate and transport mechanism. Both were found in buildings with neither PVC flooring nor wall covering, consistent with the numerous additional plasticized materials that are anticipated to be present in a typical home—cable insulation, shower curtains, etc. The most frequently identified phthalate was DEHP, which also had the highest average concentration in the dust.

Concentration of DEHP was higher in buildings with higher ventilation rates. This is an interesting factor that may mean that outdoor air contains a higher concentration of phthalates, or possibly that the higher ventilation rate brought in additional sources of particles, which drew even more phthalates out of the plasticized PVC products.

OTAKE ET AL (2004)

This study presents the concentrations of phthalate and phosphate esters in newer construction homes in Japan. Of the phthalate esters analyzed, Di-Butyl Phthalate (DBP) and DEHP were detected frequently and at a higher concentration than the other compounds. The authors assume that the vinyl (PVC) cloth or paint may be the source of DBP and DEHP, taking into consideration the general usage of these compounds in Japan.

XU AND LITTLE (2006)

The amount of DEHP on the airborne particles is roughly four times greater than that in the gas-phase. The particles essentially “scrub” the DEHP out of the system by transporting more DEHP out of the test chamber than in the case without particles. This paper presents empirical evidence that the amount of DEHP off gassing from a PVC surface increases when the amount of airborne particles are increased. One connection between this study and the sediment phthalate fate and transport mechanism is that in the majority of urban areas the predominant source of fine particulates are vehicles. Although, in the Puget Sound, fine particulates from fireplaces and woodstoves can be the major source during winter months (PSCAA 2006).

CLAUSEN ET AL (2004)

This study aimed to quantitatively determine the DEHP emission characteristics of PVC flooring under controlled conditions. They determined that the emission rate of DEHP was limited by gas-phase mass transport (i.e., by off gassing not by leaching) and the dust layer increased the emission rate by increasing the external concentration gradient above the surface of the PVC. Dust was essentially a sink for DEHP. Also, the authors estimated that about one-half of the emitted DEHP was deposited on the internal surfaces.

Outdoor Air Particulate Studies

Given that the pathway of DEHP from plasticized PVC to sediments involves airborne particulates, this section summarizes some of the recent literature on outdoor air particulates.

ZHENG ET AL (2006)

Spatial variations of source contributions to fine organic carbon (OC) and fine particles in the southeastern United States were investigated. Primary emission sources were wood combustion, gasoline engine exhaust, diesel engine exhaust. Since DEHP sticks to fine particles, and more particles in the air draw more DEHP out of the PVC, the presence of fine particulate in the atmosphere is an important part of the DEHP fate and transport mechanism.

HO ET AL (2006)

Fine particulate matter produced by vehicular emissions is the main air pollution problem in Hong Kong. Automobile emission plus secondary aerosol and diesel vehicles are responsible for 62 percent of the PM2.5 mass.

PALMGREN ET AL (2003)

The contribution of ultrafine particles from diesel vehicles is dominating in streets. Traffic generated particles that penetrate to the indoor environment will be transformed by physical and chemical processes and reaction with other air substances during transport. There is a connection between outdoor air and indoor air.

Comparison to Occurrence Data

The occurrence of phthalates in outdoor air is compared to the occurrence in the environment. To provide a basis for understanding the diffuse nature of phthalate sources to air, please refer to Table D.1, which provides information on the concentrations of DEHP in outdoor air and rates of atmospheric deposition.

ATMOSPHERIC DEPOSITION DATA

None of the air agencies contacted measure phthalates in air. In fact, a request of the Puget Sound Clean Air Agency brought a referral to the work of Bruce Tiffany (King County member of the Work Group) and Rick Fuller (City of Tacoma phthalate expert) for information on phthalates in air.

King County and City of Tacoma have measured atmospheric deposition of phthalates at multiple stations within their respective jurisdictions. The vast majority of the reported numbers for air deposition flux range from a little more than 1 to a little more than 2 ug/m^2/day, with 2 ug/m^2/day being a reasonable approximation of general air deposition flux in the more densely urbanized areas of Puget Sound. Diffuse sources (i.e., end uses of products) explain this lack of variability between results obtained in the Thea Foss and Lower Duwamish drainage basins.

There is ample DEHP in the urban environment to account for such deposition rates. For example, if the Great Lakes air deposition flux estimate of 0.5 ug/m^2/day was used as a uniform nationwide deposition rate (including the vast extent of rural lands), this would only require a source of approximately 4 millions pounds per year of DEHP (1 to 2 percent of annual U.S. production).

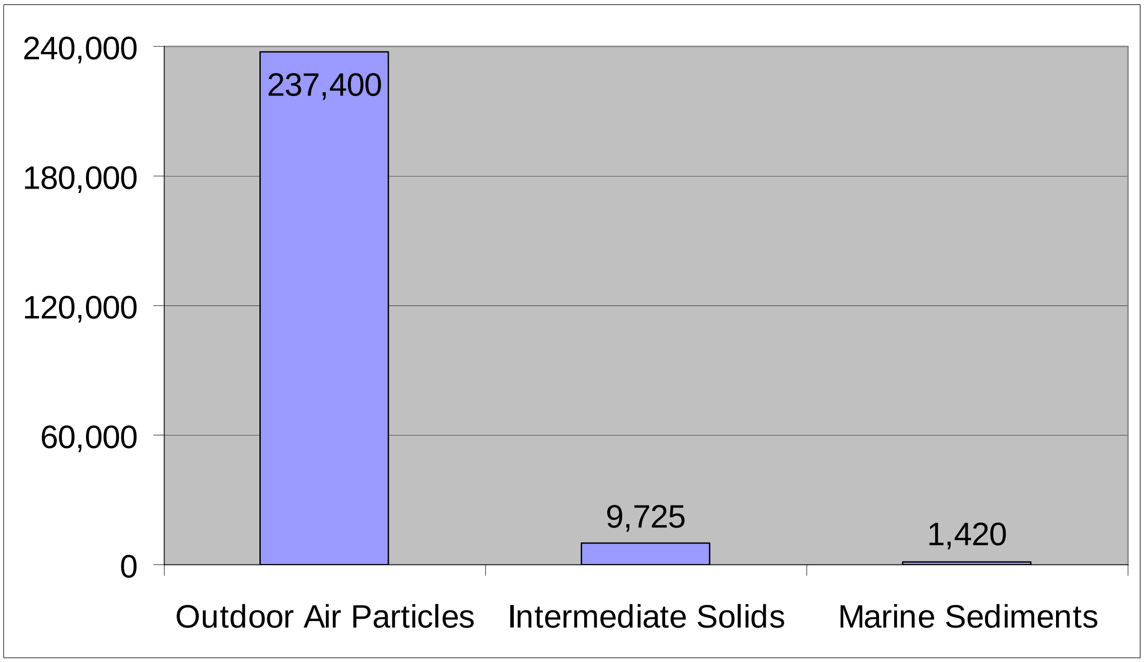
UBIQUITOUS OCCURRENCE

One of the messages from the occurrence data was the lack of variability in the central tendencies within the separate media. For instance, the City of Tacoma's *2006 Stormwater Source Control Report* determined that the concentration of DEHP in sediments from storm lines were not statistically significantly different over 6 separate drainage basins. Diffuse sources consistent with atmospheric deposition explain this lack of variability.

INDUSTRY IS NOT THE PRIMARY SOURCE

This would require proving a negative, but the highest solids concentrations anywhere in the occurrence data are in typical household dust. This supports the conclusion that plasticized PVC associated with the typical urban environment is a primary source of DEHP. The publications listed above draw consistently similar conclusions regarding diffuse atmospheric sources for DEHP.

Finally, the graph below of the various solid phases along the pathway (particles in air, particles in stormwater, and particles in sediments) shows a predictable progression of higher concentrations near the source and lower concentration near the sink.



These numbers come from the Work Group's occurrence studies and represent a median (or central tendency) of the data set. The outdoor air particle data comes from Teil et al (2006); the intermediate solids data are from the in-line sediment trap and catch basin studies in the Work Group occurrence data, and the marine sediments data are from Ecology's SEDQUAL data base.

Summary of Information

Over the course of many months and meetings, the Work Group processed a great deal of information and research about phthalates. Complete bibliographies for each of the Work Group's areas of interest are attached to the notes from technical Work Group meetings (available on-line at http://www.ecy.wa.gov/programs/tcp/smu/phthalates/phthlates_hp.htm). Ultimately, the Work Group agreed that the following reasoning fairly defines why and how phthalates impact urban sediments in Puget Sound.

- Hundreds of millions of pounds of DEHP are produced in the U.S. each year. 90 percent goes into flexible PVC products, some of which last for 5–50 years.
- Millions of pounds more are imported each year in the form of end use products.
- Thus, there is a reservoir of billions of pounds of DEHP in the urban areas of the U.S. in the form of plasticized PVC in end use products.
- Pure DEHP off gasses from these products.
- Vapor phase DEHP sticks to fine particles, more particles in the air draw more DEHP out of the plasticized PVC.
- Vehicles in the urban environment produce the majority of the fine particles.
- The atmospheric deposition of DEHP is diffuse.
- Particles falling on impervious surfaces or directly into the waterway persist in the environment long enough to accumulate in sediments.

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Sediment Phthalates Work Group

Overview of Technical Research on the Air–Stormwater–Sediment Pathway

Tables

Table D.1
Di-(2-Ethylhexyl)-Phthalate (DEHP) Comparison: Summary of Literature Information

	DEHP								Notes
	Min	Max	Mean	Median	Central Tendency	Detect Freq (%)	n	Reference	
Outdoor Air									
Paris, France - vapour, ng/m^3	3.4	25.7	13.2	12.3	12.3			Teil et al (2006)	
Paris, France - particulate, ng/m^3	2.4	10.4	5.4	5.2	5.2			Teil et al (2006)	
Netherlands - Industrial, ng/m^3	0.7	333.0	103.2	39.5	39.5		24	Peijnenburg and Struijs (2006)	
Netherlands - Highly populated, ng/m^3	0.7	72.0	41.6	52.0	52.0		23	Peijnenburg and Struijs (2006)	
Chilliwack, British Columbia, ng/m^3			3.6		3.6			Belzer (2004)	
Air at 1m, 10m & 100m from a Greenhouse, ng/m^3	<3.3	13.0	6.8	4.0	4.0	67	3	Tienpont et al (2000)	
Germany - vapour, ng/m^3	0.0	0.2	0.1		0.1		6	Xie et al (2006)	
Germany - particulate, ng/m^3	0.7	1.4	1.0		1.0		6	Xie et al (2006)	
Netherlands - 2 Background, ng/m^3	0.7	57.0	17.2	9.0	9.0		52	Peijnenburg and Struijs (2006)	
North Sea - vapour, ng/m^3	0.2	0.4	0.3		0.3		10	Xie et al (2005)	
North Sea - particulate, ng/m^3	1.0	1.1	1.0		1.0		10	Xie et al (2005)	
Rural background, ng/m^3	<3.3	<3.3	<3.3	<3.3	<3.3	0	3	Tienpont et al (2000)	
Outdoor Air, ng/m^3			<100.0		<100.0	0	1	Toda et al (2003)	
Indoor Air									
Massachusetts, ng/m^3	<59	1,000		77	77	68	102	Rudel et al (2003)	
New York, ng/m^3	50	410	220	220	220		30	Adibi et al (2003)	
Krakow, ng/m^3	80	1,100	430	370	370		30	Adibi et al (2003)	
Laboratory Air, ng/m^3	81	156	109	91	91		3	Tienpont et al (2000)	
Parking Garage Air, ng/m^3			1,046		1,046		1	Tienpont et al (2000)	
Greenhouse Air, ng/m^3			309		309		1	Tienpont et al (2000)	
Clean Room, ng/m^3	<100	<100	<100	<100	<100	0	4	Toda et al (2003)	
Office, ng/m^3	<100	200	133	<100	<100	33	3	Toda et al (2003)	
Calculated Air in a Highly Heated Car - Highest Conc., ng/m^3			640,000		640,000		1	Fujii et al (2003)	Testing at 70°C (158°F)
Outdoor Air Particles									
Paris, France - particulate, ug/Kg	300	631,500	296,300	237,400	237,400			Teil et al (2006)	
Indoor Dust									
Massachusetts, ug/Kg	16,700	7,700,000		340,000	340,000	100	101	Rudel et al (2003)	
Air Deposition									
Lower Duwamish Waterway Basin									
Beacon Hill, $ug/m^2/day$	1.0	1.6	1.3	1.2	1.2	100	6	Tiffany (2006 pers comm)	Blank subtracted data
Duwamish, $ug/m^2/day$	1.6	12.2	6.8	6.7	6.7	100	7	Tiffany (2006 pers comm)	Blank subtracted data
Georgetown, $ug/m^2/day$	1.2	3.0	2.4	2.5	2.5	100	8	Tiffany (2006 pers comm)	Blank subtracted data
King Co Intl Airport, $ug/m^2/day$	0.7	2.3	1.6	1.6	1.6	100	8	Tiffany (2006 pers comm)	Blank subtracted data
South Park Com. Cntr., $ug/m^2/day$	1.1	6.4	3.1	2.4	2.4	100	8	Tiffany (2006 pers comm)	Blank subtracted data
Thea Foss Waterway Basin									
So 78th & "L" Street, $ug/m^2/day$	ND	1.9	1.6	1.6	1.6	50	4	Fuller (2006 pers comm)	Blanks were ND so no subtraction.
Alexander Ave, $ug/m^2/day$	ND	2.5	1.5	1.5	1.5	50	4	Fuller (2006 pers comm)	Blanks were ND so no subtraction.
Central Treatment Plant, $ug/m^2/day$	ND	2.4	1.6	1.9	1.9	75	4	Fuller (2006 pers comm)	Blanks were ND so no subtraction.
Municipal Building, $ug/m^2/day$	ND	2.0	1.2	1.2	1.2	50	4	Fuller (2006 pers comm)	Blanks were ND so no subtraction.
Tacoma Dome, $ug/m^2/day$	ND	2.6	2.5	2.5	2.5	67	3	Fuller (2006 pers comm)	Blanks were ND so no subtraction.

	DEHP								Notes
	Min	Max	Mean	Median	Central Tendency	Detect Freq (%)	n	Reference	
Great Lakes, North America									
Great Lakes, ug/m^2/day			0.5		0.5			Eisenreich et al (1981)	
Europe									
Agricultural Land in Denmark, ug/m^2/day			0.5		0.5			Vikelsoe et al (2002)	
Paris, France - ug/m^2/day			2.4		2.4			Teil et al (2006)	

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